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Human Resources for Science & Technology:

The Asian Region

Surveys of Science Resources Series
Special Report
National Science Foundation
NSF 93-303

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Foreword

The adequacy of future human resources for science and engineering is an important issue for the United States. This report is designed to further the understanding of this issue by providing a reliable data base and analyses for a region that contributes significantly to the global stock of scientists and engineers—the Asian region. Many international organizations are concerned about this topic. For example, the International Council of Scientific Unions is studying existing and projected human resources in science and engineering in order to be able to advise its national members in their future science policy. The Organisation for Economic Co-operation and Development and the Commission of the European Communities have also been active in discussing these topics.

We hope that this publication will also be of assistance to an Asian regional association, the Pacific Economic Cooperation Council, which is seeking to develop a reliable data base on science and technology (S&T) indicators in this region, and to the emerging S&T indicator groups in developing countries.

This report complements and supplements the National Science Board's *Science and Engineering Indicators* volumes and several other reports prepared by the Division of Science Resources Studies.

Kenneth M. Brown
Director, Division of Science Resources Studies
Directorate for Social, Behavioral,
and Economic Sciences

May 1993

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This report was prepared by Jean M. Johnson, Senior Science Resources Analyst, Science and Engineering Indicators (IND) Program, Division of Science Resources Studies (SRS), National Science Foundation (NSF).

The data base developed to prepare this report builds on data provided by the Division of Statistics of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). Through an annual survey sent to more than 150 countries, UNESCO gathers worldwide data on higher education, research, and other dimensions of development, which it has generously provided to NSF.

To verify and update the UNESCO data, NSF was fortunate in receiving full cooperation from individuals in Ministeries of Education and in science and technology indicator groups in each of the six Asian countries studied in this report. In addition to their other contributions, these individuals have provided their national primary sources on higher education and research and development so that NSF could develop a reliable data base on human resources for science and technology. Their names, affiliations, and addresses are listed in the Contacts section of the report. This voluntary exchange of information is very encouraging and will assist SRS in completing several other regional profiles.

The NSF Division of International Programs supported this research for 1 year, funding the detail of the author to SRS. Jennifer Bond, Program Director, IND, saw the value of this research, arranged for its continued support within the Division, and provided access to the SRS library of international materials and consultation with the Division grantees in the academic research community. Colleagues within SRS and the Office of Planning and Assessment provided technical advice. Guidance and review were provided by Jennifer Bond and Kenneth M. Brown, Director, SRS.

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Acronyms

ASEAN	Association of Southeast Asian Nations
CAS	Chinese Academy of Science
CIP	Classification of Instructional Programs
CSIR	Council for Scientific and Industrial Research (India)
FTE	Full-time equivalent
GDP	Gross domestic product
GNP	Gross national product
ICP	International Comparison Program
IITs	Indian Institutes of Technology
IMF	International Monetary Fund
IPEDS	Integrated Postsecondary Education Data System
ISCED	International Standard Classification of Education
ITRI	Industrial Technology Research Institute (Taiwan)
KAIST	Korean Advanced Institute of Science and Technology
KIST	Korea Institute of Science and Technology
KOSEF	Korean Science and Engineering Foundation
NIEs	Newly industrialized economies
NS&E	Natural science and engineering
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
$PPPs	Purchasing power parity dollars
R&D	Research and development
RSE	Research scientist and engineer
S&E	Science and engineering
S&T	Science and technology
STA	Science and Technology Agency (Japan)
UNESCO	United Nations Educational, Scientific, and Cultural Organization

1. Overview

In the last 15 years, the Asian region's production of natural science and engineering (NS&E) degrees has grown dramatically, as have its economy and investment in research and development (R&D) and its attendant need for scientists and engineers. The countries studied in this report—the People's Republic of China (China), India, Japan, Singapore, the Republic of Korea (South Korea), and the Republic of China (Taiwan)—are ancient cultures with traditions of scholarship that cannot be adequately described by examining the last 15 years of data. However, data presented in this report on their growth in degrees, R&D, and gross domestic product (GDP) are indicators of the growing significance of this region to world science. The region's production of NS&E degrees at the bachelor's level was over a half a million in 1990; the number of doctoral degrees awarded in these fields was almost 10,000.

These six countries spent $91 billion in 1987 constant purchasing power parity dollars ($PPPs)[1] in overall R&D in 1990. The combined GDP of all six countries in $PPPs surpassed that of the United States in the mid-1980s.

Several Asian countries are emulating Japan in developing their economies through increasing their capacities in high technology. Many policies are devoting resources to high technology production, processing, and distribution, including developing a science and engineering labor force.

This report concludes with implications for the United States of this Asian growth in science and technology capabilities. Some of the implications for the United States are as follows:

- These Asian countries presently depend on and will continue to use the U.S. higher education system. They cannot meet the demand for higher education fast enough nor can they staff new or expanded domestic institutions without graduate training abroad, often in the United States.

- Foreign graduate student enrollment in U.S. universities and preference for NS&E degrees will help to maintain U.S. doctoral programs' emphasis in these subjects. Doctoral programs in science and engineering fields in the U.S. have grown relatively faster than in non-science and engineering fields. Over the 16-year period 1975–90, the ratio of NS&E degrees to total doctoral degrees in the United States increased from 35 to 45 percent. Since Asian foreign graduate students come mainly for science and engineering fields, they are, and will continue to be, an integral part of U.S. universities' science and engineering strengths.

- Asian countries with high technology economies will compete with the United States for the Asian-born graduates of U.S. universities. Though Asian scientists and engineers will continue to contribute to the U.S. labor force, more will probably return to Asia.

In addition, there are obvious implications for production of high technology products, but they are not analyzed in this report. A forthcoming National Science Foundation report, *Technology Development and Competitiveness: The Asian Region*, will analyze these implications.

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[1] Purchasing power parity dollars ($PPPs) are used to convert a country's national currency expenditures to a common currency unit that allows *real* international quantity comparisons to be made. $PPPs are based on "market basket" pricing exercises. All dollar amounts in this report are in 1987 constant $PPPs. See section 8, Methodology and Notes on Data Series, for details on why $PPP conversions are preferable to official exchange rates.

2. Research Approach

Differences in economic growth among countries are leading to shifts in research and development (R&D) capabilities among major regions of the world. In particular, growth of the regional economies of Western Europe and the Pacific Rim nations is facilitating greater rates of growth in their civilian research programs compared to the growth rate for U.S. civilian research programs (National Academy of Sciences 1990, p. 4).

This report focuses on the human dimensions of R&D in six Asian countries—the People's Republic of China (China), India, Japan, Singapore, the Republic of Korea (South Korea), and the Republic of China (Taiwan). Data on academic degrees in the natural sciences and engineering are examined together with demographic and macroeconomic data in an attempt to identify trends in human resources for science and technology (S&T) in the Asian region. Asian trends are compared with trends in the United States to illustrate potential similarities and differences in the area of human science and engineering resources.

The report provides a consistent data base on human resources for science in the above-mentioned six Asian countries. In addition to data on population, education, and S&T personnel, the 15-year time series also include gross domestic product (GDP) and R&D expenditures in purchasing power parity dollars ($PPPs). These data provide the basis for identifying time trends in human S&T resources as well as key indicators of their future growth and demand for scientists and engineers. A final section of the report discusses prospects for the future and implications for the United States created by this Asian growth in science and technology.

Several caveats are in order. First, data are compiled from numerous national and international sources and may not be strictly comparable. In addition, degree categories in different countries may not be academically equivalent.[2] Finally, some data series do not cover complete periods, and missing data were estimated to compile a regional series. Although these data problems are not trivial, every attempt has been made to develop trends that are approximately equivalent at the broad aggregate level. The degree data were verified country by country through national educational statistics (see Bibliography). Educational statistics for each country were categorized by broad fields of science. American and foreign scholars familiar with higher education in each country translated documents and reconfigured university departments' statistics to the universally accepted classification scheme, the International Standard Classification of Education (ISCED), and the U.S. Classification of Instructional Programs (CIP).[3]

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[2] This report does not deal with the quality of education in Asian or U.S. universities.

[3] See section 8, Methodology and Notes on Data Series.

3. Regional Summary

This report examines six Asian countries—the People's Republic of China (China), India, Japan, Singapore, the Republic of Korea (South Korea), and the Republic of China (Taiwan)—which represent 77 percent of the Asian population and 42 percent of the world's population. These six countries annually produce more than one-half million natural science and engineering (NS&E) bachelor's degrees, more than twice as many as the United States (see tables 1 and A-3). They produce approximately equal numbers of engineering and natural science graduates at the bachelor's level.[4]

The United States, with one-tenth the combined population of these countries, produces comparable numbers of advanced degrees and more than twice as many doctoral degrees in science and engineering (S&E). (See tables 2, A-5, and A-7.) However, of the approximately 22,853 doctoral degrees granted in S&E in the United States in 1990, around 3,200, or approximately 14 percent, were awarded to students from these six Asian countries. Tables 2 and 3 indicate that these Asian countries depend on U.S. graduate schools to educate a significant proportion of their doctoral students.[5] In 1990, the number of S&E doctoral degrees awarded to Asians from these countries by U.S. universities was 30 percent of the number obtained within these countries.[6]

How has this pool of scientists and engineers grown during the 1970s and 1980s, and what are the prospects for the 1990s? The following section examines the growth in S&E education from 1975 to 1990 and the prospects of the Asian region producing a growing share of the world's NS&E degrees. Further sections will explore potential connections between this growth in education and Asia's needs for S&E personnel. Those needs are driven by the countries' research and development (R&D) investment, increasingly sophisticated manufacturing, and growing economies. A regional summary of these three dimensions—human resources, R&D investment, and economic growth—is followed by country-specific details on each dimension. Near-term prospects for Asia's human resources

Table 1. Bachelor's degrees in S&E in selected Asian countries and the U.S, by field: 1990

Field	Selected Asian countries	United States
Natural science	252,767	105,021
Engineering	261,410	64,705
Natural science and engineering	514,177	169,726
Social science	196,284	159,368
Total science and engineering	710,461	329,094

SOURCE: See table A-3.

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[4] Natural science fields include physical; biological; earth, atmospheric, and oceanographic; agricultural; and math and computer sciences. Medical sciences are not included.

[5] Doctoral degrees received from other Asian countries, and in Canada and Europe, would raise the total number of degrees for these countries.

[6] Not all of these Asian doctoral graduates of U.S. universities return home. Percentages of those who plan to stay in the United States are given, by country, in section 7.

Table 2. Doctoral degrees in S&E in selected Asian countries and the U.S.: 1990

Field	Selected Asian countries	United States
Natural science	6,812	11,368
Engineering	2,856	4,892
Natural science and engineering	9,668	16,260
Social science	746	6,593
Total science and engineering	10,414	22,853

SOURCE: See table A-7.

Table 3. Doctoral degrees in S&E granted to Asian students by U.S. universities: 1990

Country	Acquired in U.S. university
China	940
Taiwan	906
South Korea	673
India	612
Japan	73
Total	3,204

SOURCE: National Science Foundation 1991

for science and technology are provided in a concluding section.

Human Resources

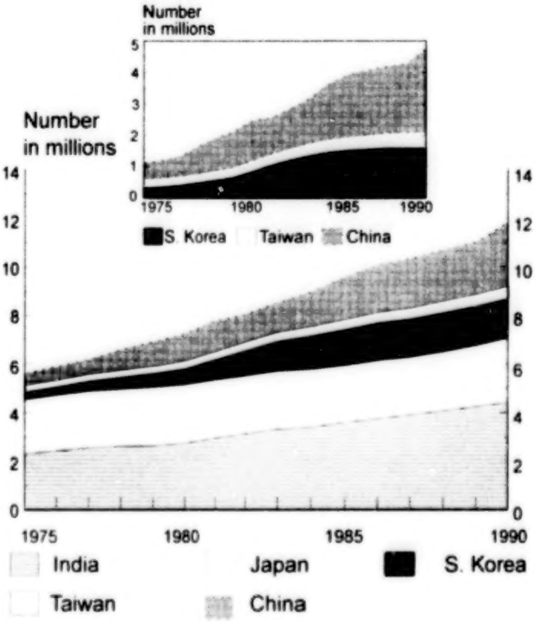
Enrollment in Higher Education

Total university enrollments in the six Asian countries studied have doubled since 1975 (see figure 1), and there are two distinct groups among these countries: those whose enrollments grew steeply in the 1950s and 1960s (India and Japan) and subsequently leveled off, and those whose enrollments have grown in the last 15 years (South Korea, Taiwan, and China) (see figure 1 inset). Even with this growth, only about 5 percent of the college-age segment of the 2.5 billion total population in the Asian region is enrolled in a university. The region has a potential for extensive further growth in university education.

India accounts for more than a third of the total enrollments. Singapore does not show up on the graph because of its small number of university students relative to other Asian countries. (See table A-1 for data on university enrollments for all six countries.)

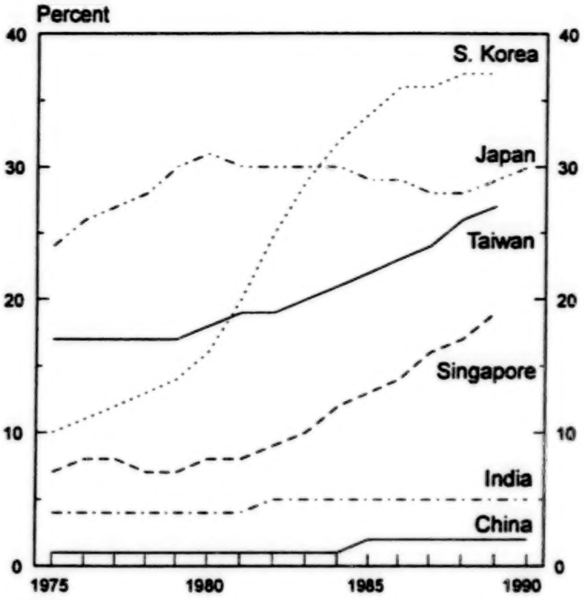
The number of people acquiring a university education affects the quality of the labor force and the economic development potential of a country. Within individual countries, the ratio of university students to the total 20- to 24-year-old population varies widely, as shown

Figure 1. Growth in enrollment in higher education in selected Asian countries: 1975-90



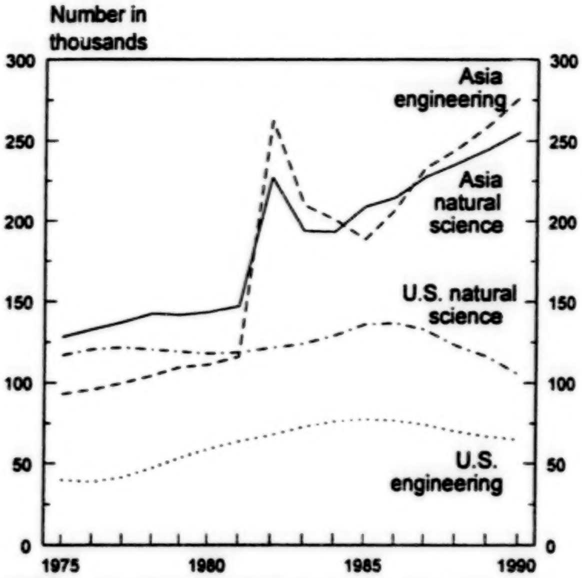
NOTE: See table A-1.

Figure 2. Ratio of university enrollments to the 20- to 24-year-old population in selected Asian countries: 1975-90



NOTE: See table A-2.

Figure 3. Bachelor's degrees in natural science and engineering in Asia and the U.S.: 1975-90



NOTES: Asian degree data include six countries: China, India, Japan, Singapore, South Korea, and Taiwan. See table A-3.

in figure 2. China is on the low end of the spectrum. Despite impressive, massive expansion of higher education systems in the 1980s, only 1.7 percent of China's young people are enrolled in universities.

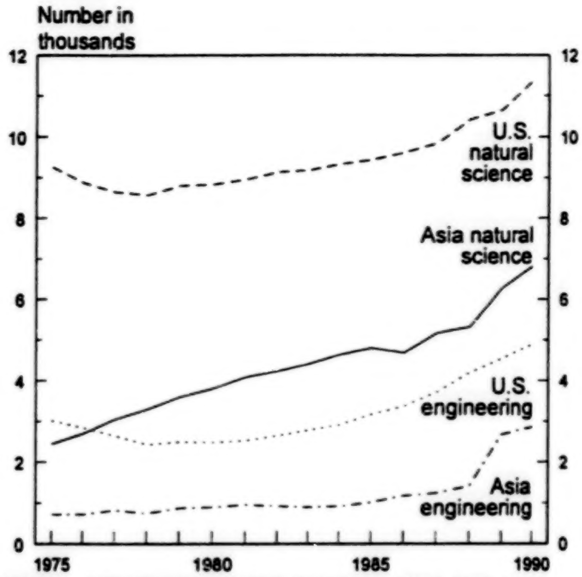
On the high end of the spectrum, South Korea tripled its enrollments from 1975 to the present and now has the highest proportion of its college-age group (36 percent) studying in universities. India, with a huge and growing population, maintained 5 percent of this age group in universities during this period. Taiwan increased from 16 to 27 percent; Japan from 24 to 29 percent. (See table A-2 on university enrollment ratios.)

Higher Education Degree Data

Over the 15-year period examined, these Asian countries together have increased their annual production of bachelor's degrees in natural sciences by 60 percent, and have tripled their annual production of engineering degrees (see figure 3). Asia's high annual number of degrees in natural sciences continues to rise as these countries attempt to go beyond "quality engineering" and low-cost production to design capability and "knowledge-based" innovative products and processes (Tufts University 1991). At the bachelor's level, the number of natural science degrees awarded in Asia is approximately equal to the number of engineering degrees. At the doctoral level, the number of natural science degrees is almost three times higher than the number of engineering degrees. This proportion is similar to that found in the United States and Europe; careers in natural science fields often require doctoral training.

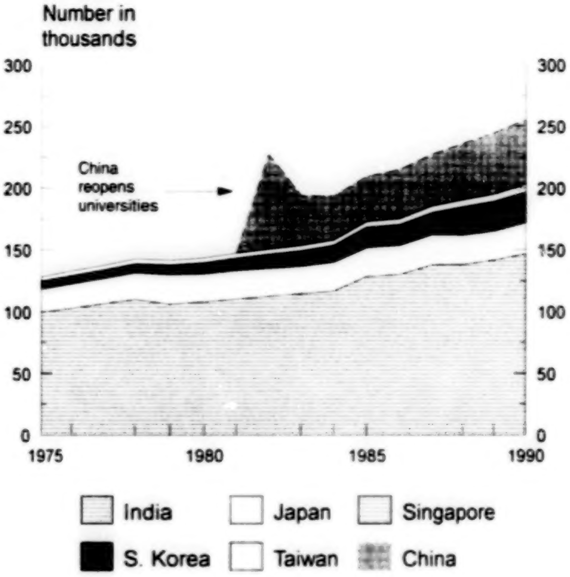
In the United States, the number of bachelor's degrees awarded in the natural sciences remained relatively stable from 1975 to 1983, grew to a peak in 1985–86, and has since declined steadily in absolute numbers. The number of natural science degrees awarded in the United States has consistently been double that of U.S. engineering degrees. At the doctorate level (see figure

Figure 4. Doctoral degrees in natural science and engineering in Asia and the U.S.: 1975-90



NOTES: Asian degree data include six countries: China, India, Japan, Singapore, South Korea, and Taiwan. See table A-7.

Figure 5. Bachelor's degrees in natural science in selected Asian countries: 1975-90



NOTES: Singapore is not visible because of relatively small number. See table A-3.

4), half of the U.S. degrees are awarded to foreign students. Within Asia, programs in China, South Korea, and Taiwan built up these countries' advanced degree capability and doctoral-level training in the 1980s. The jump in the number of doctoral degrees awarded in Asia in 1989 results from the inclusion of China in the Asia total in 1989, the first year for which doctoral degree data are available from China.

Degrees in the natural sciences in Asia. India accounts for well over 50 percent of the bachelor's degrees awarded in natural sciences in Asia, as seen in figure 5. The world's largest democracy, India is also the world's foremost educator of bachelor's- and doctoral-level natural scientists. India produced more bachelor's degrees in natural science fields than the United States in the early 1970s, and has again surpassed the United States in natural science degrees since 1987. India, with approximately 146,000 graduates in 1990, is followed at a distance by China, with 52,000 natural science graduates in 1990.

The pattern of Indian prominence in the natural sciences also occurs in advanced degrees (master's and doctorates) in Asian countries. India accounts for half of the 56,000 advanced degrees and for more than half of the 6,800 doctoral degrees in natural science in this region (see tables A-5 and A-7).

Degrees in engineering. All six Asian countries studied are increasing their production of engineering degrees, as shown in figure 6. China and Japan are and will be the main producers of bachelor's degrees in engineering for the region. China has the highest number, with 128,000 graduates in 1990.[7] Japan follows with 81,000 graduates.

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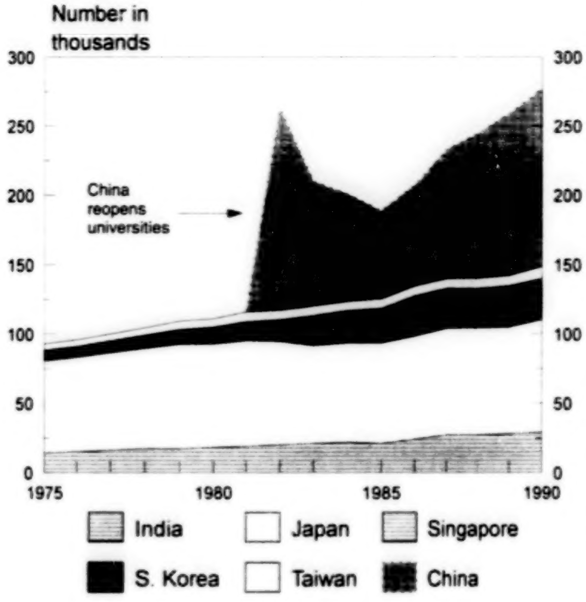
[7] The very high number of engineering graduates in 1982 in the China data reflects the flood of older students completing degrees in reopened universities in the late 1970s. The number then settles down and steadily increases.

Figure 6. Bachelor's degrees in engineering in selected Asian countries: 1975-90



NOTES: Singapore is not visible because of relatively small number. See table A-3.

Rates of growth in production of engineering degrees differ widely across Asian countries. Japan has been producing approximately the same number of engineering graduates for more than 10 years, whereas China appears to be at the beginning of a growth curve. In South Korean universities, the growth in the number of engineering degrees has recently leveled off; for the past 3 years their engineering degrees have remained stable. Japan and South Korea may be already producing as many engineering graduates as possible given their declining college-age populations in the 1990s. They have 30 to 40 percent of their young people enrolled in universities and award 15 to 20 percent of all degrees in engineering. As with bachelor's degrees, China and Japan are the main producers of advanced degrees (master's and doctorates) in engineering (see tables A-5 and A-7).

Asian students in U.S. universities. The entire Asian region has dominated all other world regions in using the U.S. higher education and research infrastructure (Institute of International Education 1991a). The number of Asian students in U.S. universities has increased from 20,000 per year in 1975 to 200,000 per year in 1989–90. In 1980, 5 of the 10 leading countries of origin in foreign enrollment in U.S. institutions of higher education were Asian; by 1990, 9 of the top 10 were Asian.

Of all foreign students attending U.S. universities at the undergraduate level, 43 percent are Asian; at the graduate level, 65 percent are Asian. Of the 33,000 Chinese students enrolled in U.S. universities in 1989–90, a large majority were enrolled in graduate programs. Similarly, the majority of Indian, South Korean, and Taiwanese students in the United States were enrolled in graduate studies, as shown in table 4. A very large percentage of these Asian students are studying science and engineering in U.S. universities: 96 percent of Taiwanese students and 93 percent of Indian students were in S&E fields in 1989–90.

Japan and Singapore send their students to U.S. colleges and universities mainly at the undergraduate level. Of the 30,000 Japanese students attending U.S. universities in 1989–90, 62 percent were enrolled in undergraduate programs and more than half were in non-S&E fields. Students from other Asian countries, such as Hong Kong, Malaysia, and Indonesia, also study in the United States, mainly at the undergraduate level.

The U.S. higher education institutions are a significant source for doctoral education of Asian students. For individual countries the figures vary substantially, as shown in table 5 and figure 7. Doctoral degrees received from other Asian countries, and from Canada and Europe, would raise the total number of degrees for these countries.

As shown, the majority of Taiwan's doctoral degrees are from the United States. About one-half of South Korea's and one-third of China's are from U.S. universities. Japan obtains only a small fraction of doctoral degrees in the United States (National Science Foundation 1991, table 6), as shown in figure 7.

Foreign graduate students' enrollment in U.S. universities has increased the concentration of U.S.

Table 4. Asian students in U.S. universities in natural science and engineering, by level: 1989–90 and 1990–91

Country	Number of students		Percentage under-graduate	Percentage graduate	Percentage natural science	Percentage engineering
	1989–90	1990–91				
China	33,390	39,600	12.9	82.7	44.0	20.1
India	26,240	28,860	21.1	75.5	40.9	52.5
Japan	29,840	36,610	61.7	19.5	31.0	14.0
Singapore	4,440	4,500	73.2	25.0	35.0	52.0
S. Korea	21,710	23,360	24.1	69.7	45.4	35.6
Taiwan	30,960	33,530	19.0	76.3	51.0	45.0

SOURCES: Institute of International Education 1990, 1991a

NOTES: Percentages by level and field are estimated from Institute of International Education 1990. The percentages of undergraduate and graduate students do not add to 100; balance have research appointments. The percentage of natural science and engineering fields do not add to 100; the balance are in non-S&E fields.

Table 5. Doctoral degrees in natural science and engineering awarded domestically and in the U.S. for selected Asian countries: 1990

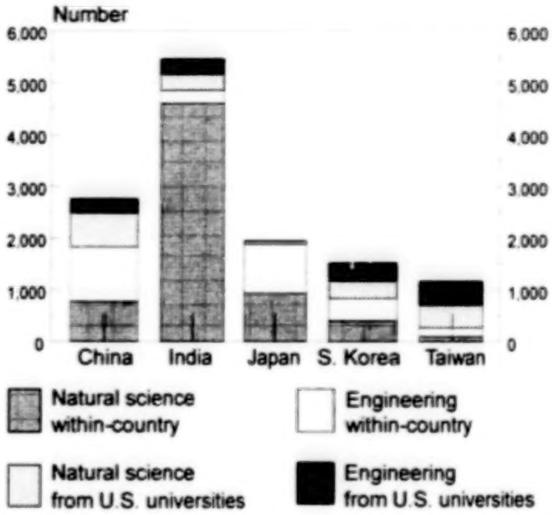
Countries	Within-country		U.S. universities	
	Natural science	Engineering	Natural science	Engineering
China	772	1,054	660 (46.1%)	280 (21.0%)
India	4,600	250	311 (6.3%)	301 (54.6%)
Japan	937	948	56 (5.6%)	17 (1.8%)
S. Korea	399	439	343 (46.2%)	350 (44.4%)
Taiwan	104	165	446 (81.1%)	460 (73.6%)

SOURCES: See table A-7; National Science Foundation 1991.

NOTE: Figures in parentheses are U.S. doctoral awards as a percentage of the country's total doctoral degrees in that field.

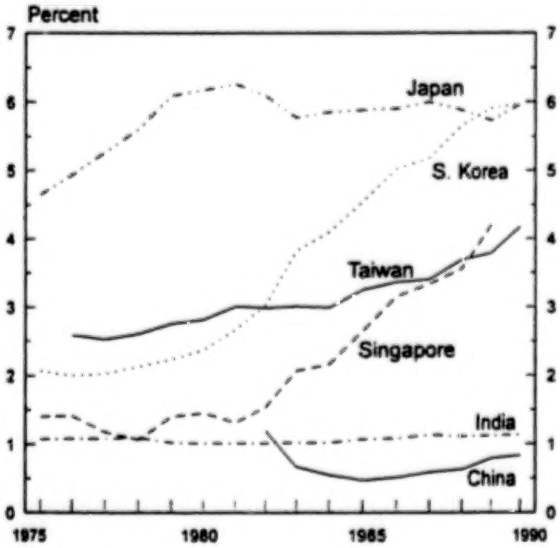
doctoral degrees in natural science and engineering. Between 1975 and 1990, the ratio of NS&E doctoral degrees to total doctoral degrees in the United States increased from 35 to 45 percent.

Figure 7. Natural science and engineering doctoral degrees awarded domestically and in the U.S. for selected Asian countries: 1990



NOTE: See table A-7.

Figure 8. Percentage of Asian 22-year-olds holding natural science and engineering bachelor's degrees in selected Asian countries: 1975-90



NOTE: See table A-13.

Participation Rates in NS&E Degrees at the Bachelor's Level

Most Asian countries except Japan increased the percentage of 22-year-olds receiving NS&E degrees between 1975 and 1990, as shown in figure 8. After increasing in the 1970s and 1980s, Japan's high percentage of 22-year-olds obtaining NS&E degrees (6 percent) has fallen slightly since 1987 as both preferences for education in natural science and engineering and the college-age population declined (Myers 1992). South Korea dramatically increased its NS&E degrees from 2 to 6 percent of its 22-year-olds since 1975. Taiwan increased its NS&E degree awards from 2 to 4 percent of its 22-year-old population over the last decade. China and India, with their huge populations, are maintaining their participation rates of 0.8 percent and 1.1 percent, respectively. If China and India continue to maintain these rates, the world stock of science and engineering graduates will be greatly augmented. (See table A-13 on participation rates in NS&E degrees.)

Ratio of science and engineering degrees to total degrees. Asian universities award a higher proportion of their degrees in fields of natural science and engineering than do U.S. or European universities: between 25 and 55 percent, as shown in figure 9.

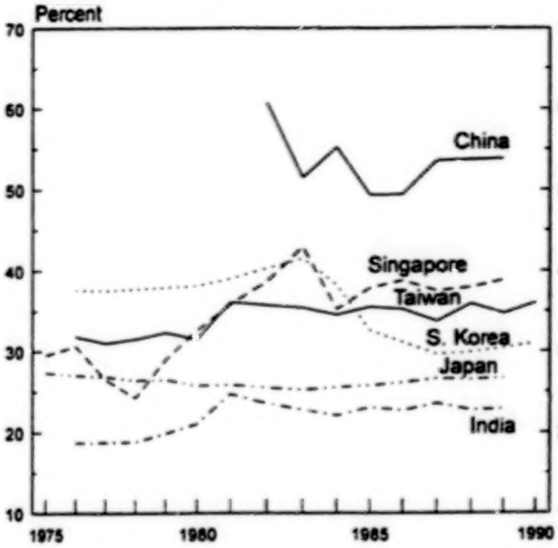
Asian countries (except India) especially favor engineering. Forty percent of all China's university degrees are given in engineering fields (see figure 10). India has a different pattern than the other five Asian countries. India has very large numbers of natural science degrees and a high ratio of natural science degrees to total degrees; however, there is not an equal emphasis on engineering. The ratio of engineering degrees to total degrees is the lowest in Asia. India's pattern is the reverse of Japan's, which has more than 20 percent of its degrees in engineering, but relatively few people studying basic sciences. (See table A-12.) When social science degrees are included, Japan has the highest proportion of S&E degrees in the Asian region; close to 66 percent of its university degrees are given in natural science, engineering, or social science.

Demographic changes. In the 1990s there will be decreases in the absolute numbers in the college-age population in the highly industrialized countries of the United States, Western Europe, and Japan. In Japan, the number of 18-year-olds will decrease by one-half million between 1992 and 2000. Government policy is to attract older adults and foreign students to Japanese universities. Japan has a "tenfold-increase policy" for foreign students and is projecting an enrollment of 100,000 foreign students by the beginning of the 21st century (Government of Japan, Science and Technology Agency 1991b, p. 16). (See also tables A-14 and A-19 to see the slow growth of Japan's population and labor force in the 1990s. See table A-15 to see the decline in the number of 20- to 24-year-olds in Japan from 10 million to 8.5 million between 1995 and 2000.)

However, among developing Asian countries, the college-age population of India will continue to increase and will surpass that of China after the year 2002, as shown in figure 11. In the year 2000, China is expected to have 95 million people in the 20- to 24-year-old group; India will have 89 million. For comparison purposes, in the year 2000, Japan will have 8.5 million people in the college-age population, South Korea will have 3.9 million, and Taiwan will have 1.9 million. Western European countries will have between 3 and 4 million people in their college-age populations, and the United States will have around 19 million (Bos, Vu, and Levin 1992).

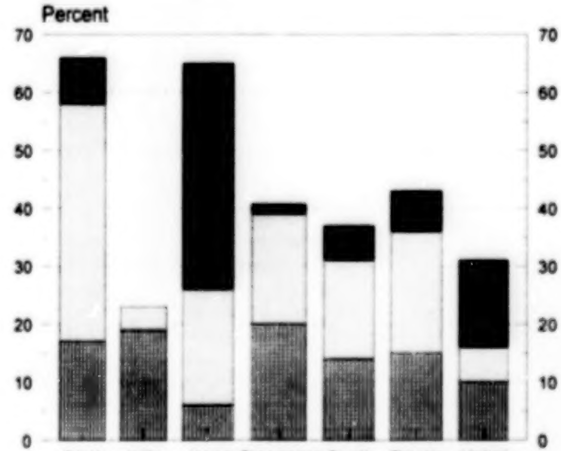
Can India and China develop these vast potential human resources for science? It will be an extremely difficult task because only a small percentage of their populations now obtain science degrees. These countries are, at great sacrifice, expanding university education and stressing science and engineering. Will they be able to employ all the S&E graduates? The next sections will describe Asian R&D investment and GDP. An attempt will be made to show relationships among these science and economic indicators in section 7, Prospects for the Future.

Figure 9. Ratio of natural science and engineering degrees to total bachelor's degrees in selected Asian countries: 1975-90



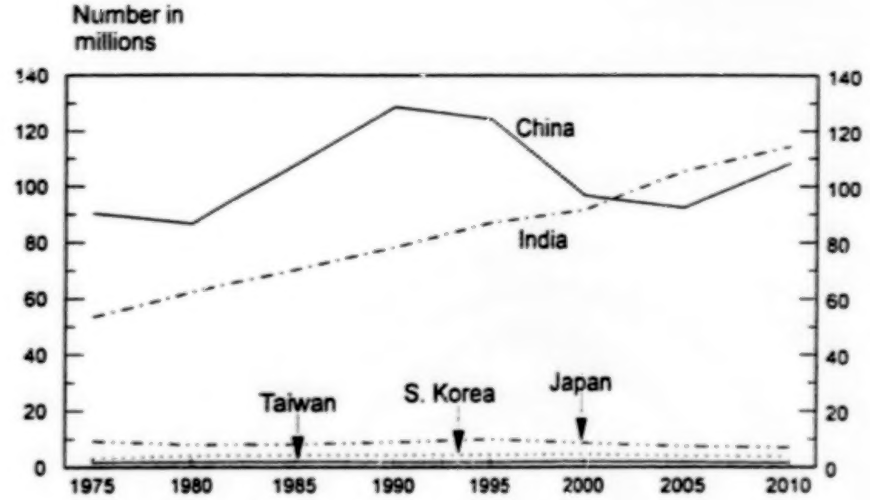
NOTE: See table A-12.

Figure 10. Ratio of S&E degrees to total bachelor's degrees in selected Asian countries and the U.S.: 1990



NOTES: India does not report social sciences. See table A-12.

Figure 11. Number of 20- to 24-year-olds in selected Asian countries: 1975-2010 (projected)



NOTE: See table A-15.

Research and Development Expenditures

In 1990, the combined R&D expenditures of the six Asian countries studied were approximately $91 billion in 1987 constant purchasing power parity dollars ($PPPs). (Throughout this report, dollar amounts will be in 1987 constant $PPPs.) Asian R&D amounted to 1.5 percent of the countries' combined GDP. In the same year, the U.S. total R&D was $130 billion, as shown in figure 12, amounting to 2.65 percent of the national GDP.

National R&D surveys and reporting, from which these data are derived, are well developed in most of the six Asian countries, but are just being organized in China.[8] Japan, Taiwan, and South Korea have been conducting national R&D surveys for decades. India has been conducting R&D surveys and reporting biennially since the early 1970s. Singapore has conducted biennial national R&D surveys for the past 10 years.

The R&D spending in five Asian countries was combined to arrive at a regional total for each year between 1975 and 1989. Only China was excluded from the total Asian R&D because data from China, with a consistent definition of R&D, exist for only 1 year. The growth rate of the combined R&D spending was approximately 9 percent between 1975 and 1989. Estimations to 1992 use this 9 percent growth rate.

To estimate Chinese R&D spending to 1992, a low growth of 2.5 percent and a high growth of 6 percent were assumed. With the past 9 percent growth in the region, and China's high and low estimates for R&D spending added, the overall Asian R&D budget estimate for 1992 is $110 billion, as shown in figure 12. In 1990, the United States had 1.4 times the overall R&D investment as the six Asian countries combined, but with a lower growth rate than Asian countries. The U.S. growth rate (net after inflation)

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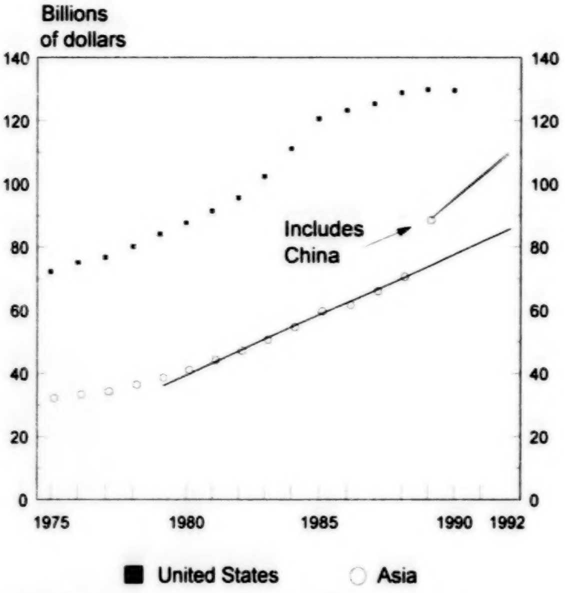
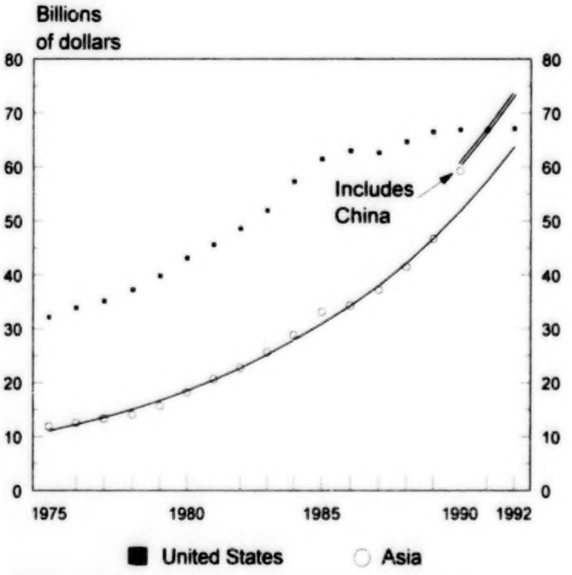
[8] China is also just developing its science and technology (S&T) indicators capability. Although R&D data exist for several years, S&T indicators staff in the State Science and Technology Commission caution that uniform definitions for R&D have only been in place since 1990.

Figure 12. R&D in selected Asian countries and the U.S.: 1975-92



NOTE: Data are estimated for 1991 and 1992. See table A-16.

Figure 13. Industrially funded R&D in selected Asian countries and the U.S.: 1975-92



NOTE: Data are estimated for 1991 and 1992. See table A-17.

over the last 6-year period has been approximately 1.1 percent.

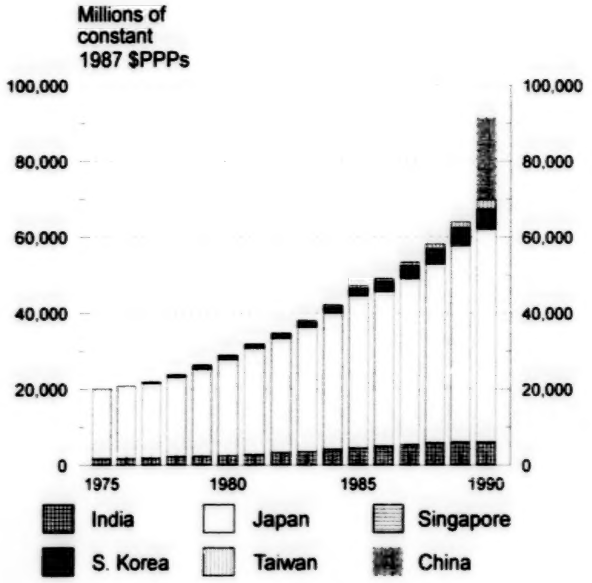
These Asian countries' nondefense R&D in 1990 is uncertain. Only Japan and India publish figures on their military R&D budget. Japan's defense R&D is 1 percent of the total; India's defense R&D has been between 15 and 20 percent. Taiwan and South Korea do not include defense research in their R&D reporting; Singapore and China include defense R&D in their 1990 R&D reporting, but do not specify the percentages. More refined R&D data are required to compare civilian research budgets.

Industrially Funded R&D

In 1990, U.S. private industries funded more R&D than the industries of the six Asian countries combined. However, industrially funded R&D in the six Asian countries is growing faster than their overall R&D, and is estimated to reach approximately $73 billion in 1992, slightly more than the $67 billion in the United States, as shown in figure 13. The U.S. growth rate in this area has slowed to 1.5 percent over the last 6 years, down from 7 percent during the period 1975 to 1985.

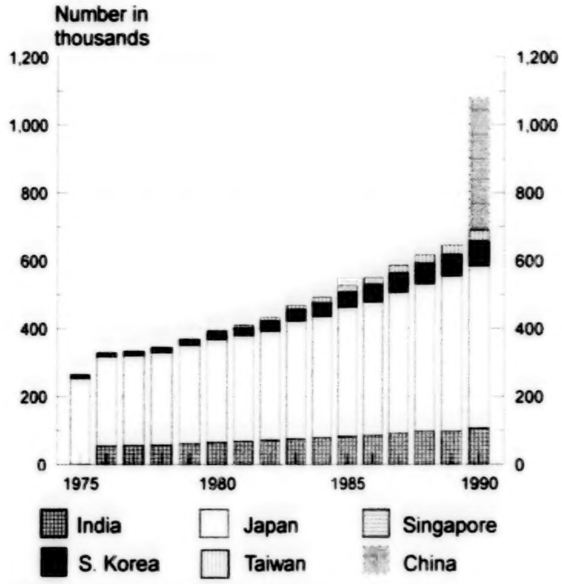
According to one recent analysis, all Asian countries in proximity to Japan that now assemble products for labor-short Japan would like to increase their R&D and hence the technological sophistication of their own products. Singapore, Taiwan, and South Korea, as well as other Association of Southeast Asian Nations (ASEAN) countries, are establishing science parks to strengthen indigenous R&D, attract foreign high technology firms, and allow shared research facilities between industries and universities. South Korea, Taiwan, Singapore, and Hong Kong are particularly interested in joint ventures with the United States and multinationals that include technology transfer (Institute of Electrical and Electronics Engineers, Inc. (IEEE) 1991).

Figure 14. R&D expenditures in selected Asian countries: 1975-90



NOTES: Only data for 1990 were available for China. Singapore is not visible because of relatively small number. See table A-18.

Figure 15. Scientists and engineers in R&D in selected Asian countries: 1975-90



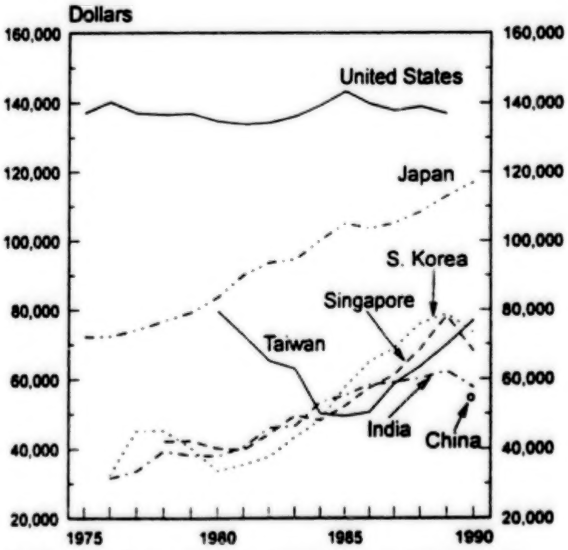
NOTES: Only data for 1990 were available for China. Singapore is not visible because of relatively small number. See table A-19.

Science and Engineering Personnel

The combined sum of R&D expenditures of the six Asian countries has more than quadrupled over the period 1975 to 1990 (see figure 14), and the number of S&E personnel in R&D has followed the same growth curve (see figure 15). In 1990, with China data included, research scientists and engineers numbered more than 1 million, comparable to the numbers of research scientists and engineers in the United States.

R&D expenditure per research scientist and engineer (RSE) is an indication of the level of support and quality of the science infrastructure available to research scientists and engineers. Figure 16 shows the trends in support of science during the last 15 years. All of the Asian countries studied have reached more than $50,000 per research scientist and engineer; Japan is approaching $120,000.

Figure 16. R&D expenditures per research scientist and engineering in selected Asian countries and the U.S.: 1975-90



NOTES: Only data for 1990 were available for China. See table A-20.

Gross Domestic Product

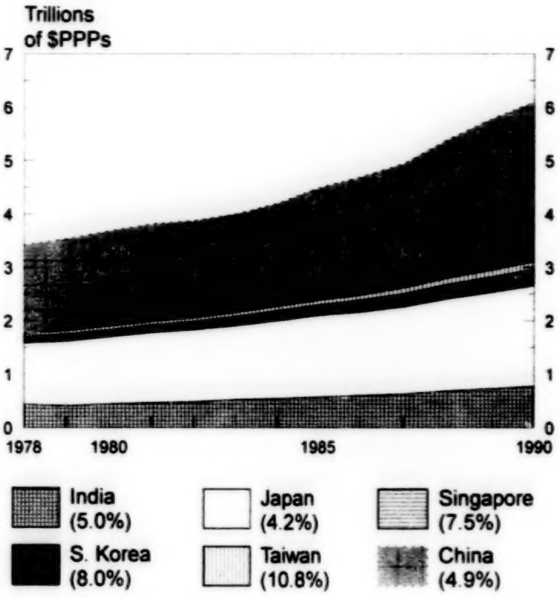
The six Asian countries studied have had the fastest growing economies in the world in the last 15 years. Figure 17 shows the growth in gross domestic product (GDP) for each country in $PPPs. (GDP using official exchange rates would be far lower for China and India.[9]) As shown in figure 18, in 1975 the U.S. GDP was somewhat larger than that of the six Asian countries combined. Between 1975 and 1992, however, the positions reversed, and the combined GDP of the six Pacific Rim countries is now somewhat larger than that of the United States.

Related S&E Indicators

The overall economic performance of a country appears to be related to several S&T indicators. The percent of GDP invested in R&D (see table 6) correlates with related indicators of support for S&E personnel. The Asian countries studied fall into three groupings in their standard of living and support for R&D personnel. China and India have the lowest GDP per capita, the lowest percent of GDP in R&D, the lowest number of S&E personnel per 10,000 of the population, and the lowest R&D investment per research scientist and engineer.

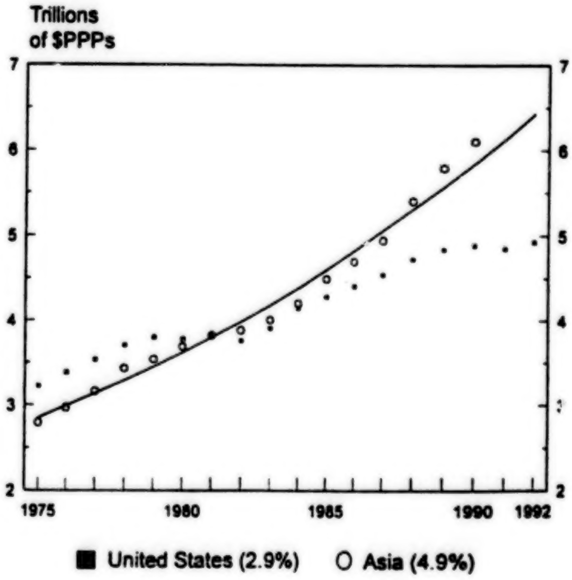
Singapore, Taiwan, and South Korea form a midrange in these indicators. Japan has the highest GDP per capita and support for S&E personnel, approaching that of the United States.

Figure 17. Growth in GDP in selected Asian countries: 1978-90



NOTE: See table A-22.

Figure 18. Growth in GDP in selected Asian countries and the U.S.: 1975-92



NOTES: Data are estimated for 1991 and 1992. See table A-22.

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[9] For a discussion of this difference in China, see Survey of China 1992.

Table 6. Support for R&D and S&E personnel by level of per capita GDP in selected Asian countries and the U.S.: 1990

Country	Per capita GDP ($PPPs) (1)	R&D as a percentage of GDP	S&E personnel in R&D	S&E personnel in R&D per 10,000 of labor force	R&D expenditures per scientist and engineer ($PPPs)
United States	19,600	2.7	949,000(2)	75.6 (2)	136,800(2)
Japan	15,296	2.9	477,866	74.9	117,068
Singapore	10,850	0.9	4,298	30.4	67,855
Taiwan	7,193	1.7	32,145	38.2	77,032
South Korea	6,342	1.9	68,831	37.2	73,297
China	2,636	.7	391,100	5.6	54,884
India	907	.8	106,000	3.3	57,465

(1) $PPPs = purchasing power parity dollars

(2) U.S. data are for 1989, the latest year for which data were available.

SOURCES: Computed, tables A-19 and A-22

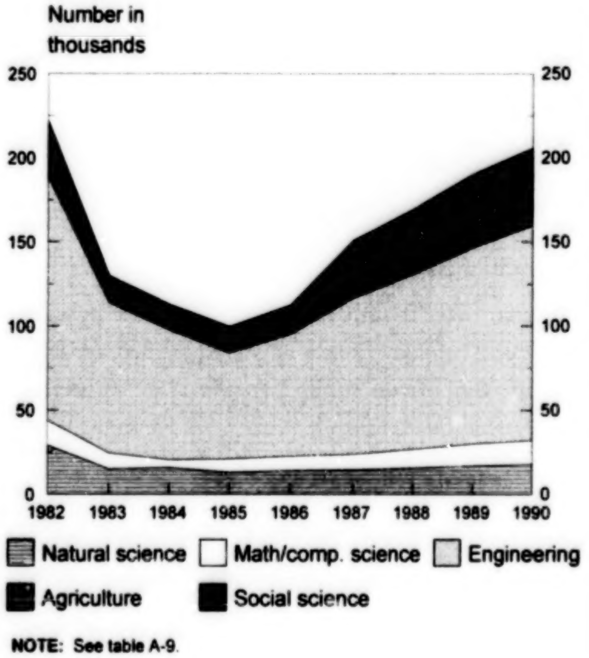
4. Human Resources by Country

Each of the six Asian countries studied for this report—China, India, Japan, Singapore, South Korea, and Taiwan—has a significant educational infrastructure and has invested heavily in its improvement to foster knowledge-based strategies for economic growth and to supply highly skilled human resources in science and engineering (S&E).

China

China's extensive research infrastructure and graduate training were greatly disrupted in the late 1950s, when scholars and researchers were told to learn from the masses during the Great Leap Forward, and when universities were used for "worker-peasant-soldier-scholars" during the Cultural Revolution of the 1960s. During this period, China tripled primary school enrollments and vastly increased enrollment in secondary schools. It was not until 1978, when Chinese Premier Deng Xiaoping announced that intellectual work is a form of labor and that education and scientific research are a form of production, that higher education was again legitimized. China reinstituted entrance exams and only the very best students have been admitted to Chinese universities since then. There are now more than 1,000 higher education institutes in China. Seventy of them provide 4-year university programs; 43 of them, the most sought after, are comprehensive universities.

Figure 19. Bachelor's degrees in S&E in China, by field: 1982-90



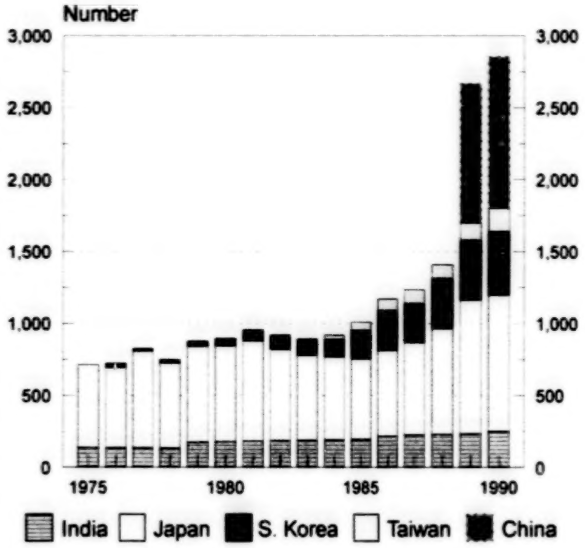
NOTE: See table A-9.

China is trying to upgrade the quality of its domestic higher education to meet high level labor requirements. In 1988, about 86 of the higher education institutes were designated as key point schools, singled out as centers of excellence for priority funding. The central government is financing 35,000 students for study abroad, while also increasing graduate programs to educate scientists and engineers within China so that fewer students have to leave.

Data that represent internationally comparable university degrees are available for China only for the years 1982–90. The very high number of graduates in 1982, the peak in the data in figure 19, reflects the flood of older students completing their degrees in reopened universities in the late 1970s. The number of students then declined and leveled off before beginning a steady increase starting in the mid-1980s.

China has the highest ratio of engineering degrees to total degrees (41 percent; see table A-12) in the Asian region, and produces more doctoral engineering degrees than Japan (see figure 20, for which there are

Figure 20. Doctoral degrees in engineering in selected Asian countries: 1975-90



NOTES: Only data for 1989 and 1990 were available for China.
See table A-11.

only 2 years of data for China).[10] China also has a strong commitment to basic science education, and produced more than twice as many bachelor's degrees in natural sciences as Japan.

India

India, like China, has a long tradition of scholarship and respect for knowledge. India's extensive university system, which has increased in enrollments by a factor of 20 since the country's independence in 1947, was first established during the colonial period. The first three universities created by the British administration were in Calcutta, Madras, and Bombay and several Indian scientists achieved worldwide distinction during the first half of this century. The first non-Western Nobel Laureate was an Indian, C.V. Raman, who received the prize for physics in 1931. Ten of India's top universities have 29 Centers of Advanced Study, including, along with those mentioned above, Banaras Hindu, Delhi, Punjab, and the Indian Institute of Science.

In postindependence India, as in China, science and engineering replaced civil service as the high prestige career. Government subsidies to higher education in science and engineering, parental urgings, and higher salaries attracted the best students to S&E fields.

The steepest growth occurred in natural science degrees in the 1950s and 1960s; the great emphasis placed by India on natural science degrees can be seen in figure 21. This emphasis on fields of natural science has resulted in India's scientific strengths in high energy physics, plant biochemistry, solid state and inorganic chemistry, microelectronic materials, polymers, and ceramics (National Science Foundation 1987).

Indian Institutes of Technology (IITs), modeled after the Massachusetts Institute of Technology, were established in the 1950s in five major cities for the study of engineering and computer sciences. They are distinguished by their extreme selectivity; every year 100,000 students take a competitive exam for 2,000 seats at these Institutes. A large number of the IIT graduates continue their studies in the United States. For example, about 20 percent of Bombay IIT graduates immediately go abroad, but the proportion may be as high as 80 percent among computer science graduates (Maddox 1984). It is not known how many of those who obtain graduate degrees return to India with even better qualifications.

The Indian bachelor's degree data from 1975 to 1990 (figure 21) show that engineering degrees are growing faster than science degrees, but are still rather small in number. Of all university degrees, 20 percent are awarded in natural science and only 4 percent are awarded in engineering. There are almost 5,000 institutes of higher education (excluding junior colleges) for the arts and sciences and only 277 for engineering.

The dominance of India in the Asian region in natural sciences can also be seen in advanced degrees (figure 22), of which 4,600 are at the doctoral level.

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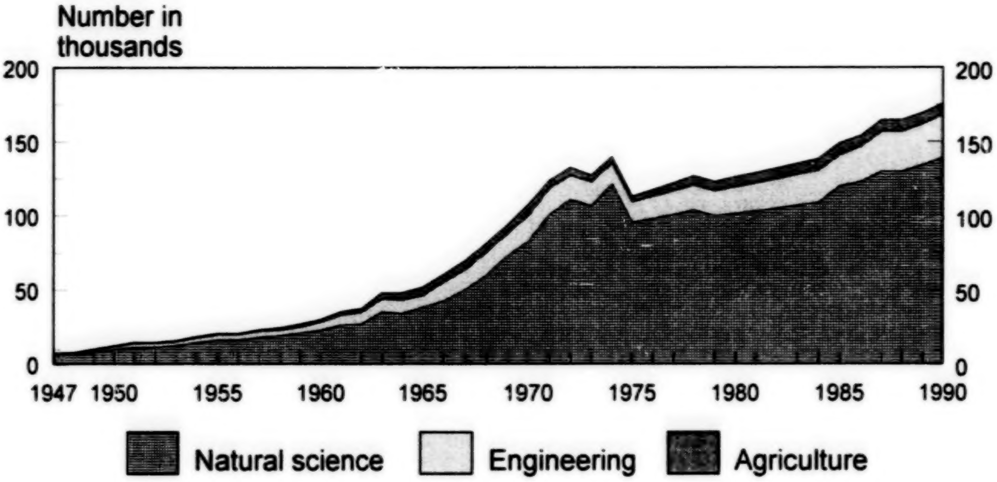
[10] China's educational statistics have doctoral degree data by field of science beginning in 1989.

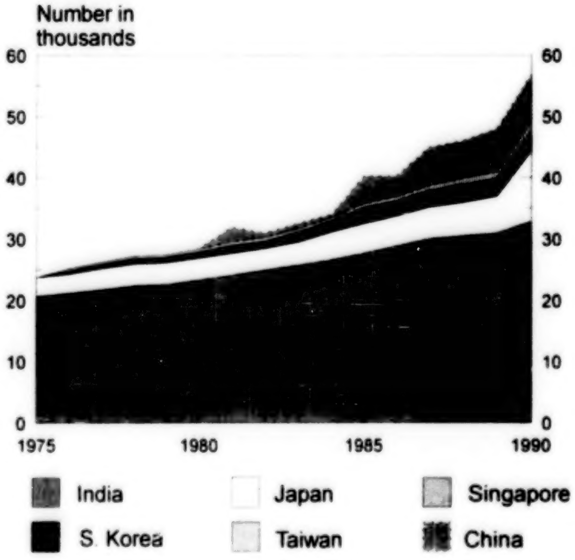
Figure 21. Bachelor's degrees in S&E in India, by field: 1947-90



NOTES: India does not report social science degrees; math is included in natural science, computer science in engineering. See table A-9.

About one-third of the students in all levels of university education are female: 33 percent of science students in universities are female; 7.9 percent of engineering students are female (Government of India, Department of Science and Technology n.d.).

Figure 22. Advanced degrees (master's and doctoral) in natural science in selected Asian countries: 1975-90

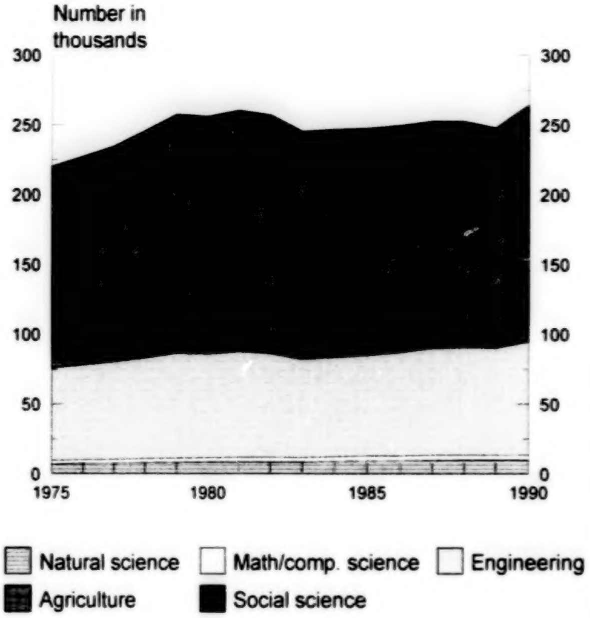


NOTES: Singapore is not visible because of relatively small number. See table A-10.

Japan

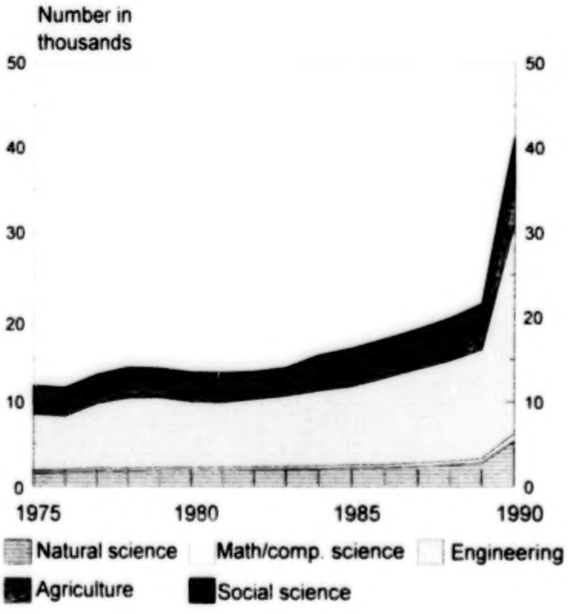
As with India, the brief period of the last 15 years does not cover the more dramatic increase in the number of S&E degrees in Japan. The sharp rise in Japanese enrollments and graduates in science and engineering occurred in the 1950s and 1960s. As part of the reconstruction after World War II, Japan made a concerted effort to increase the number of S&E degrees awarded and to double its gross national product. Over the past 10 years, Japan has educated approximately the same number of engineers annually and has slowly increased the number of natural science graduates. As figure 23 shows, Japan produces a quarter of a million S&E degrees each year, but with a very small base in natural science. The majority of S&E degrees are in engineering and social

Figure 23. Bachelor's degrees in S&E in Japan, by field: 1975-90



NOTE: See table A-9.

Figure 24. Advanced degrees (master's and doctoral) in Japan, by field: 1975-90



NOTE: See table A-10.

science. (Business is included in social sciences in Japanese education data.)

Private schools, many at the junior college level, make up 70 percent of all higher education in Japan. The Government provides 20 percent of the cost of private schools and also funds 98 public universities. A small number of these public universities, the seven old imperial universities (including the Universities of Tokyo, Osaka, and Kyoto), are the most prestigious, with very competitive entrance examinations. Japanese private universities are very large, crowded, and far less well equipped than the public universities (Swinbacks 1991), so many Japanese students opt to study abroad. Sixty-one percent of the 30,000 Japanese students in the United States in 1990 were enrolled in an undergraduate degree program (Institute of International Education 1991a).

The participation of females in S&E degrees in Japan is higher in natural sciences than in engineering or social sciences. As in many other countries, female participation in engineering is low (see table 7).

Undergraduate engineering education in Japanese universities is very broad, to expose students to many fields, in contrast to U.S. engineering undergraduate programs, in which students receive more in-depth education in specialized fields. Japanese companies prefer to provide extensive in-house training to young engineers instead of hiring older students with master's or doctoral degrees from Japanese universities. Because advanced degrees have not conferred employment benefits on those who earn them, there have been relatively few advanced degrees in NS&E in Japan.

Recently, however, there has been growth in advanced S&E degrees (master's and doctorates) in Japan, as shown in figure 24.

With the goal of increasing basic research, Japan's science and technology policy statements call for a strengthening of Japan's graduate education, increased financial assistance, and research funds for doctoral students (Government of Japan, Cabinet Decision 1992).

One example of Japan's attempt to improve graduate education is the establishment of the Research Center

Table 7. Participation in S&E degrees in Japan, by sex: 1990

Field	Total	Male		Female	
		Number	Percentage	Number	Percentage
Natural science	25,153	20,221	80	4,932	20
Engineering	81,355	78,705	97	2,650	3
Natural science and engineering	106,508	98,926	93	7,582	7
Social science	157,477	138,958	88	18,519	12
Total all fields	400,103	381,584	73	109,750	27

SOURCE: Government of Japan, Ministry of Education, Science, and Culture 1990

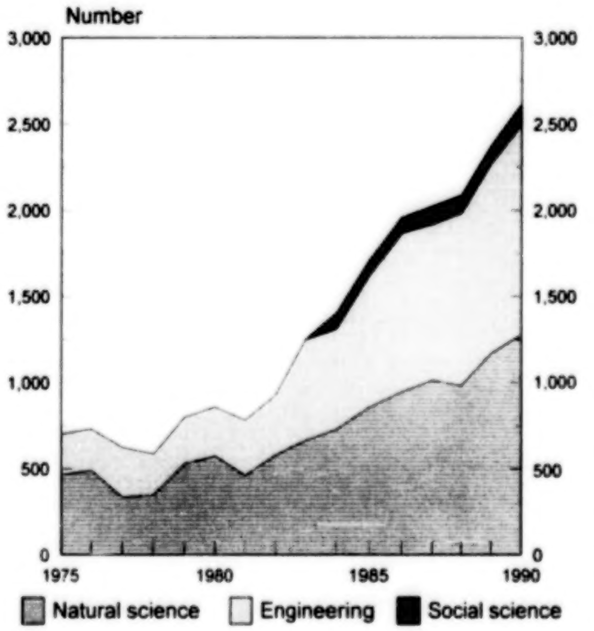
for Advanced Science and Technology at the University of Tokyo. The Tokyo Institute of Technology is also attracting foreign graduate students. Japan recruits the best engineering students from all over Asia and gives them scholarships for master's and doctoral programs at the University of Tokyo. Recruitment includes all the Indian Institutes of Technology, Chinese universities in Beijing and Shanghai, and universities in Pakistan, Bangladesh, Thailand, Indonesia, and Sri Lanka. Doctoral programs are given in English and the generous scholarships, available only to foreign students, are considered an investment. It is assumed that these graduates will serve as a bridge between the businesses of their countries and those of Japan. The Monbusho scholarships for doctoral programs add another 5 years after the doctorate for the foreign students to visit their major professor (Nishino 1992).

Singapore

Singapore has achieved remarkable economic growth because of its strategic emphasis on, and effective policies for, the development of human resources and supporting S&T infrastructure. In the 1960s, Singapore began to attract multinational corporations and embarked on a massive program in industrial training to upgrade the skill levels of workers and increase the supply of technicians and engineers. As the economy has developed, tertiary education has expanded through two polytechnics and the National University, emphasizing NS&E (see figure 25). In the 1990s, Singapore is emphasizing attracting high technology, knowledge-intensive industries and internationalizing its own local firms.

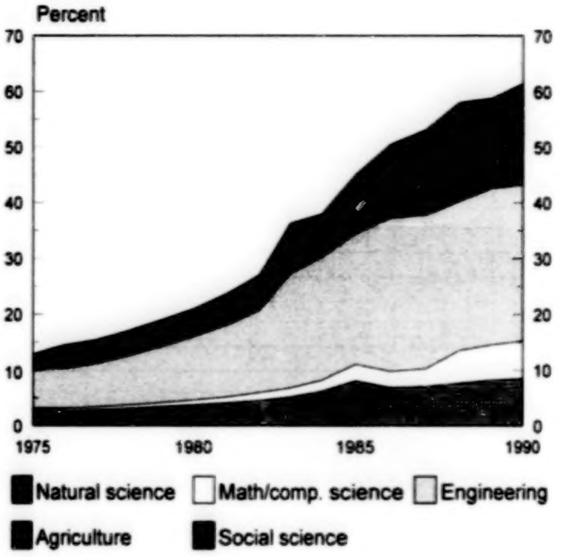
Singapore has invested heavily in the National University of Singapore to supply highly skilled scientists

Figure 25. Bachelor's degrees in S&E in Singapore, by field: 1975-90



NOTE: See table A-9.

Figure 26. Bachelor's degrees in S&E in South Korea, by field: 1975-90



NOTE: See table A-9.

and engineers. More than 32 percent of the State's research and development (R&D) is performed by the University and 40 percent of R&D personnel are there. In addition, Singapore has greatly expanded its overseas education program.

Gradually, Singapore has phased out labor-intensive industry through a high-wage policy. In recent years, the training has shifted to produce a highly specialized professional labor force, especially in the information–technology-related industry. Singapore's graduate education has expanded programs in systems science, microelectronics, advanced computer communications, and computer-integrated manufacturing.

South Korea

South Korea, like many countries in Asia, has aspired to promote coherent and self-sustained development through education. It emphasizes S&E education through special scholarships, exemption from military service, and rewarding employment. The Government's decision to double admissions quotas in 1980 was an attempt to keep up with industry's demand for engineers, computer scientists, and other specialists. New local area colleges had to be added to existing universities to ease the strain on laboratories and computer facilities. Figure 26 shows the fivefold increase in S&E degrees over the last 15 years.

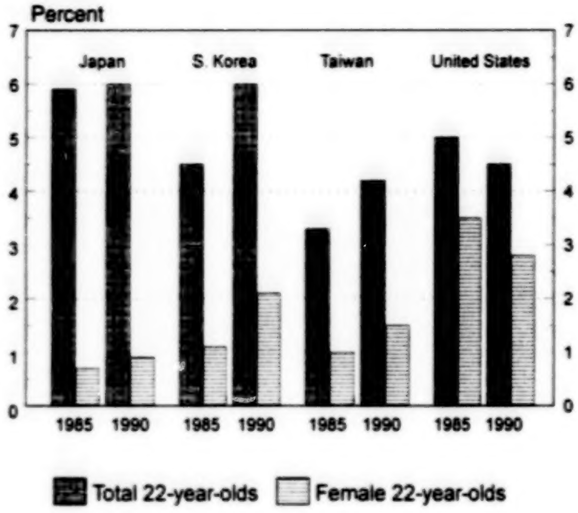
The most prestigious South Korean universities are those that survived the Japanese occupation of 1905-45. Science and engineering graduates from these universities are preferred by major industries. The Korean Advanced Institute of Science and Technology (KAIST) was established to identify gifted students in science, increase support for postgraduate training locally, and strengthen research capacity. KAIST, along with the Ministry of Science and Technology, runs an undergraduate institute for talented students who win national science scholarships. The Government is again considering doubling enrollments in engineering departments. The current S&T policy

Table 8. Participation in S&E degrees in South Korea, by sex: 1990

Field	Total	Male		Female	
		Number	Percentage	Number	Percentage
Natural science	23,195	15,953	69	7,242	31
Engineering	28,071	26,763	95	1,308	5
Natural science and engineering	51,266	42,716	83	8,550	17
Social science	10,211	7,579	74	2,632	26
Total, all fields	165,916	104,627	63	61,289	37

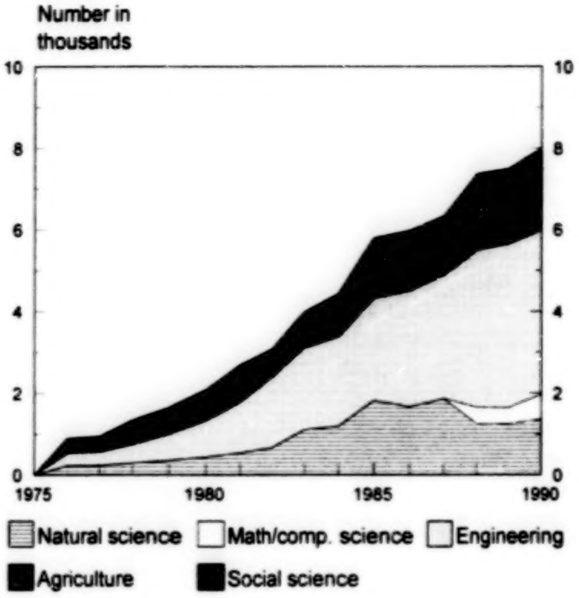
SOURCE: Government of the Republic of Korea, Ministry of Education 1990

Figure 27. Percentage of 22-year-olds with natural science and engineering degrees in selected Asian countries, and the U.S., by total and female population: 1985 and 1990



NOTE: See table A-13.

Figure 28. Advanced degrees (master's and doctoral) in South Korea, by field: 1975-90



NOTE: See table A-10.

states that university advanced degrees will be linked with industrial demands through joint research projects.

In South Korea, women receive almost one third of all bachelor degrees in the natural sciences and over one fourth of the social science degrees (see table 8).

Overall, South Korea has the highest participation of females in natural science and engineering degrees among the three Asian countries shown in figure 27. Although female participation improved slightly in these Asian countries between 1985 and 1990, both female and total 22-year-old participation in NS&E degrees declined in the United States.

South Korean graduate education is expanding rapidly to overcome the shortage of high-level personnel trained beyond the bachelor's level. Whereas there were only 800 master's and doctorate recipients from NS&E faculties in 1976, by 1990 there were 8,000, with 900 doctoral degrees (see figure 28).

To further upgrade the labor force, the Government is expanding programs to send students abroad. The Korean Science and Engineering Foundation has an enlarged scholarship program to allow some 10,000 S&E students to receive postdoctoral training abroad by the year 2000. Expatriate scientists and engineers are returning as salaries and living and working conditions improve in South Korea.

Taiwan

Taiwan, like South Korea, controls enrollments in higher education and emphasizes engineering (33 percent of all university students). Its expansion of S&E education over the last 15 years is shown in figure 29.

There are limited opportunities for graduate study in Taiwan, so students mainly study abroad for advanced degrees. The United States provides approximately 77 percent of Taiwan's doctoral degrees in natural science and engineering.

Female participation in NS&E degrees in higher education in Taiwan has gone from 1 to 1.5 percent of

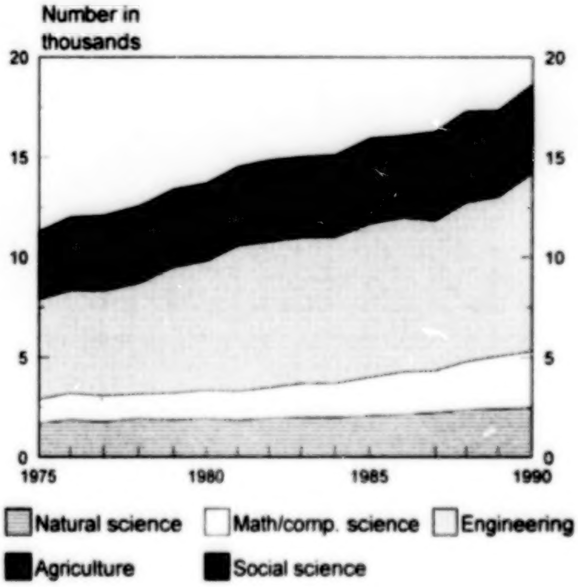
Table 9. Participation in S&E degrees in Taiwan, by sex: 1990

Field	Total	Male		Female	
		Number	Percentage	Number	Percentage
Natural science	6,533	4,723	72	1,810	28
Engineering	8,950	8,110	91	840	09
Natural science and engineering	15,483	12,833	83	2,650	17
Social science	3,174	1,167	37	2,007	63
Total, all fields	49,136	23,556	61	19,396	39

SOURCE: Government of the Republic of China, Ministry of Education 1990

the 22-year-old female population in the last 5 years (figure 27). Of the university degrees in natural sciences, 28 percent are awarded to women (see table 9).

Figure 29. Bachelor's degrees in S&E in Taiwan, by field: 1975-90



NOTE: See table A-9.

5. Research and Development by Country

Indigenous capabilities for original research and development (R&D) are central to the industrial restructuring of the Asian developing countries to more knowledge-based industries and high technology production. The performance of R&D in the Asian region is concentrated in Government and industrial laboratories. Figure 30 shows that South Korea and Taiwan have a similar pattern to each other of a large industrial research sector and significant participation of nonprofit institutes in research. China and India are similar in having a large Government research sector. A significant consequence of educational reform in China over the last 10 years is that universities have begun to do research. India does not yet survey universities in its biennial R&D survey, but university-based R&D is estimated to represent about 2 to 3 percent of India's overall research. U.S. universities performed two times more research than the universities of all six Asian countries combined—$20 billion compared with $9.6 billion in 1990 (see table A-18).

China

In 1990 China spent 12.6 billion yuan in overall R&D (in current yuan), equivalent to $21.4 billion. Of this total, the Government financed more than half and "enterprises" financed the rest, as shown in figure 31. Enterprises include large state-owned industry, as well as local, collectively owned businesses and small private enterprises in economic zones.[11] China's reform policies have made a very significant attempt to change the R&D structure and have put a burden

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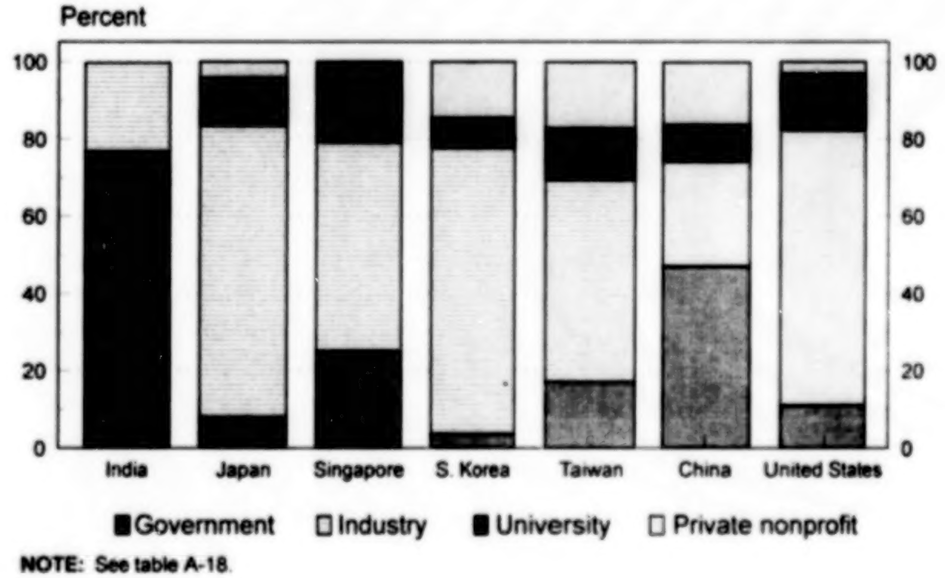
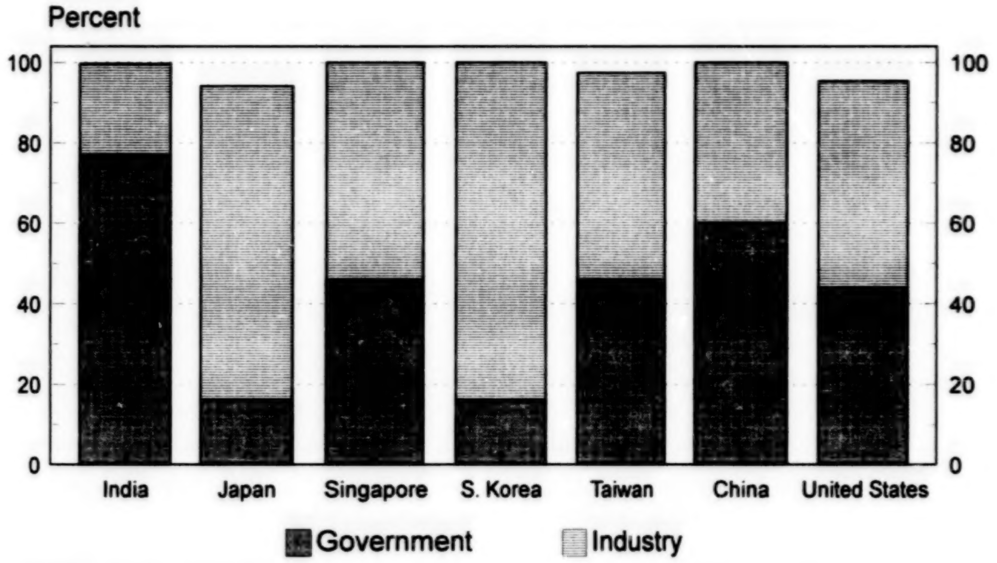
[11] This follows international standards for R&D reporting.

Figure 30. R&D in selected Asian countries and the U.S., by performer: 1990



NOTE: See table A-18.

Figure 31. R&D in selected Asian countries and the U.S., by source of funds: 1990



NOTES: In India, Government includes national industry. In China, industry includes public enterprises. See table A-17.

on industry to spend more; R&D enterprise spending grew remarkably during the 1980s. The non-State enterprise sector is the more dynamic, accounting for most of the increases in R&D. The proportion of Government as a source of funds would be even greater if research support by public industries could be disaggregated from enterprises and counted as Government spending.

China's science policy reforms have also required the large research infrastructure of the Chinese Academy of Science (CAS) to contribute to economic competitiveness. With large Government budget cuts, the CAS has been encouraged to enter cooperative ventures with domestic industry as well as with industries in Hong Kong, Singapore, and Taiwan (Suttmeier 1990a).

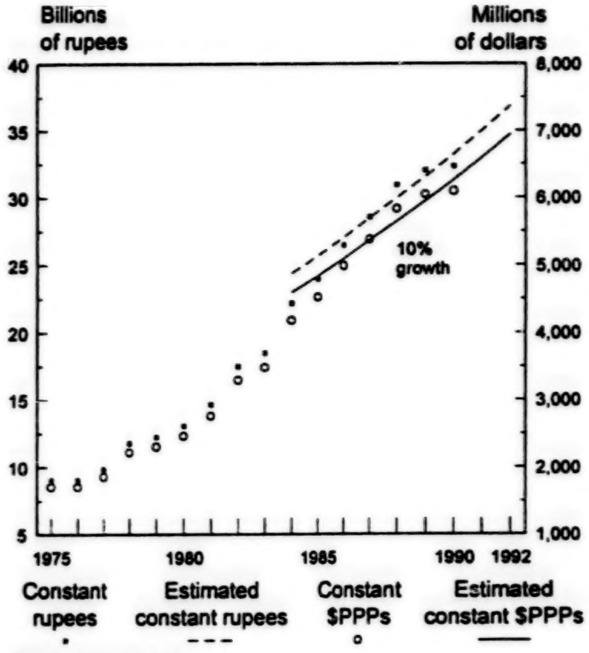
India

India built up a strong Government-dominated, broad-based science infrastructure over many years. The preindependence centers of excellence include the Tata Institute for Fundamental Research in Bombay, the Indian Institute of Science in Bangalore, and the Indian Statistical Institute in Calcutta. In the early 1900s India established advanced medical and agricultural research institutes. Since independence, India has established research centers under the Department of Atomic Energy and 36 national laboratories under the Council for Scientific and Industrial Research (CSIR) outside the university system. More recently, the Department of Space and the Ministry of Biotechnology have established several strong research centers.

India's overall R&D annual investment grew from 3 to 41 billion rupees (in current national currency) over the period 1975–90. In constant dollars, this investment grew from $1.7 to $6 billion.

In 1991, India was not able to continue the previous 10 percent growth rate in R&D (see figure 32). To control the Government's large fiscal deficit, austerity measures were introduced in 1991 which squeezed credit and suppressed growth. Gross domestic product (GDP) growth was only 2 percent; R&D decreased in 1991. India's 36 national labs under CSIR are being asked to help national industries compete globally. More of their funding will have to come from private industry contracts to develop technologies. Whereas

Figure 32. Growth in R&D in India: 1975-92



NOTE: See table A-16.

previously CSIR labs were isolated from industry, they now have a technology transfer mission. Currently, R&D expenditure by private industry is only about 5 percent of the nation's total R&D, the smallest percentage in Asia.

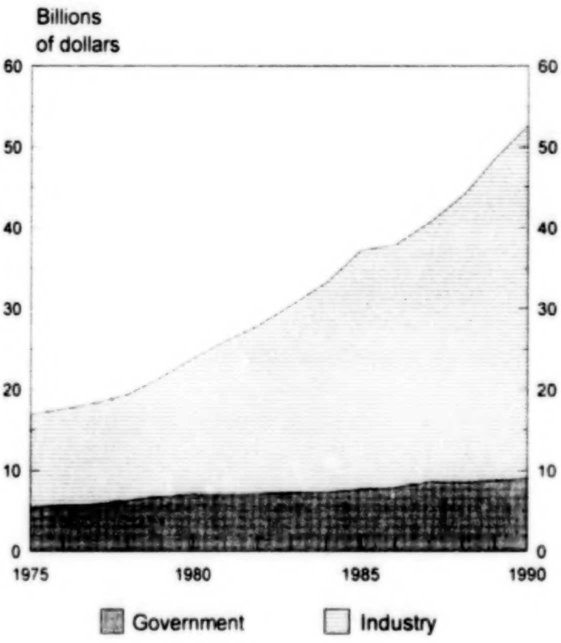
Japan

Japanese R&D is mainly supported by industry. The Japanese Government primarily supports the 16 well-equipped research institutes under the Agency of Industrial Science and Technology. The Japanese White Paper for 1991 states that the Government will double its investment in R&D in the next 5 to 10 years to expand basic research in order to advance knowledge, do ground-breaking research, and create its own technologies (Government of Japan, Science and Technology Agency 1991b).

Japanese White Papers on Science and Technology during the last 20 years have discussed the importance to Japan of increasing the support of basic research. The 1972 White Paper reviewed the accomplishments that had been made through the support of quality engineering and a high ratio of R&D investment targeted at securing competitiveness (Government of Japan, Science and Technology Agency 1972). It was rightly reasoned then that Japan had reached a stage of development in which off-the-shelf technologies were no longer sufficient to meet the challenges of environmental quality and other basic research needs. The Government did increase its support of basic research, but industry also increased its research tremendously; the Government's portion of support has therefore declined over the 15-year period, as shown in figure 33.

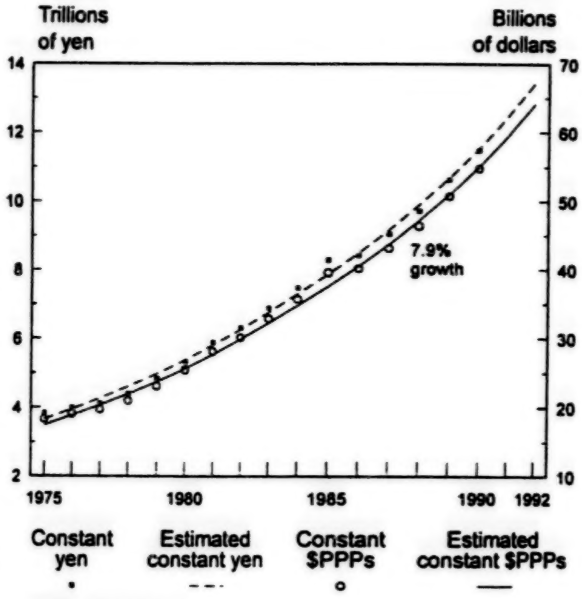
The recently revised science and technology (S&T) policy states: "Progress in basic research is not as great as had been expected" (Government of Japan, Cabinet Decision 1992, p. 5). Further, it states that Japan will now systematically renew the obsolete facilities and equipment of universities and install facilities for conducting leading and advanced research at universities and centers of excellence. Increasing

Figure 33. R&D in Japan, by source of funds: 1975-90



NOTE: See table A-17.

Figure 34. Growth in R&D in Japan: 1975-92



NOTE: See table A-16.

basic research in Japan is no longer stated as important, but rather as urgent.[12]

Japan's overall R&D investment went from 2.7 to 12 trillion yen (current currency) between 1975 and 1990. In constant dollars, this is equivalent to an investment growth from $18 to $56 billion, almost all of it in civilian research. If Japan's R&D expenditure continues this growth rate of 7.9 percent, by 1992 Japan will be spending nearly $64 billion, as shown in figure 34.

Japan's industrially funded R&D has grown faster than overall R&D. If Japan continues its 9.9 percent growth rate in industrially funded R&D, that sector will be 77 percent of that of the United States in 1992 ($52 billion versus $67 billion), as shown in figure 35.

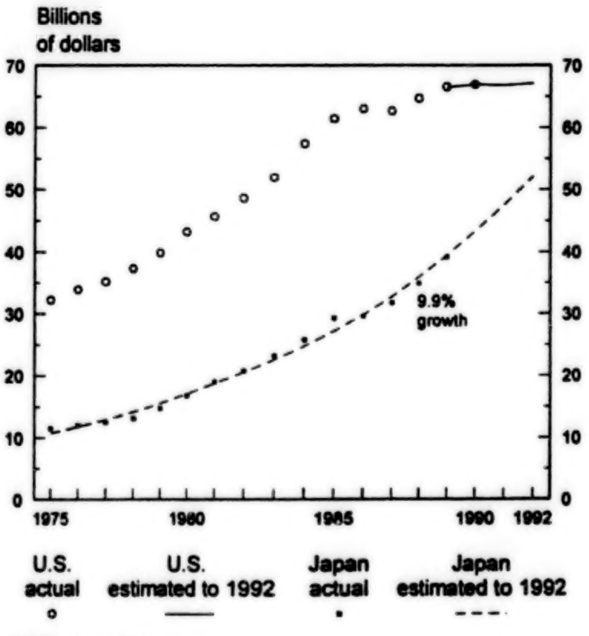
Singapore

Singapore's significance to science and engineering resources in the Asian region has not been in R&D but in its location, services, information and communication infrastructure, and skilled personnel to support multinational corporations. Singapore has developed its technology absorption capability well and now wants to develop its technology creation capability. Interest in R&D to enhance innovation is only very recent.

Singapore's institutional structure for S&T policy, the Singapore Science Council, was revamped in 1991 to become the National Science and Technology Board under the Ministry of Trade and Industry. The National Science and Technology Board sponsors R&D aimed at specific products. To reposition itself as a highly specialized economy, Singapore is setting up several research institutes: the Information Technology Institute, the Institute for Cellular and Molecular Biology, and the Institute for Manufacturing Technologies.

Government support of R&D has risen dramatically to increase the nation's innovative capacity. Multinationals have set up research facilities and initiated joint R&D projects. In addition, Singapore would like to

Figure 35. Industrially funded R&D in the U.S. and Japan: 1975-92



NOTE: See table A-17.

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[12] A recent issue of *Nature* (Swinbacks 1992) summarizes the concrete steps that would have to be taken to improve and increase basic research in Japan.

attract overseas talent to the R&D laboratories built in its new Science Park.

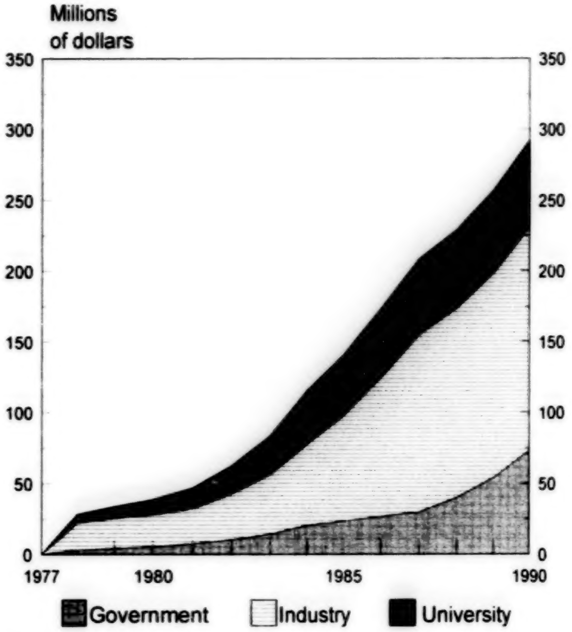
Performance by sector over the last 15 years is shown in figure 36. The private sector accounted for about 60 percent of R&D expenditures in 1989, the bulk of it in the electronics industry, with multinational corporations predominating. Singapore's industrially funded R&D is growing at 25.6 percent annually, equivalent to $158 million in 1990.

Singapore's overall R&D investment went from 38 to 638 million Singapore dollars over a 10-year period. In $PPPs, this is an investment growth from $28 to $292 million. There is a very high growth rate, averaging 20 percent annually between 1975 and 1992, but from a very insignificant R&D base, as shown in figure 37.

South Korea

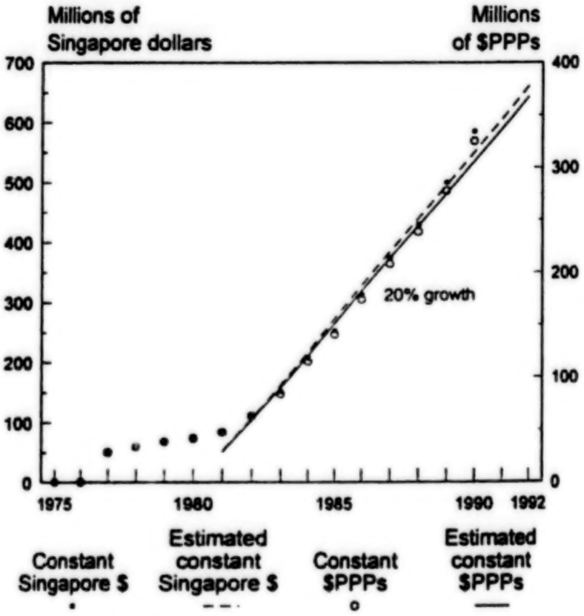
The South Korean Government has, since 1966, supported applied research through a major research and development center, the Korea Institute of Science and Technology (KIST). The Ministry of Science and Technology, established in 1967, has carried out a national R&D program since 1982 to develop long-term, large-scale high technologies that are essential for improving South Korea's comparative advantage in international trade. The program is performed through joint participation of industries, universities, and Government-funded research institutes. The Korean Science and Engineering Foundation, KOSEF, modeled after the National Science Foundation (NSF), supports basic research. Like NSF, South Korea is establishing Science Research Centers and Engineering Research Centers at universities around the country for the common utilization of advanced R&D facilities. The Daeduk Science Town, 150 kilometers south of Seoul, has 50 research institutes and shared facilities. South Korea also strives for regional distribution of research facilities and has established several smaller R&D complexes: genetic engineering in the center (Suweon), new materials in the southeast (Ulsan), and fine chemistry and precision machinery in the southwest (Hanam).

Figure 36. R&D in Singapore, by performer: 1977-90



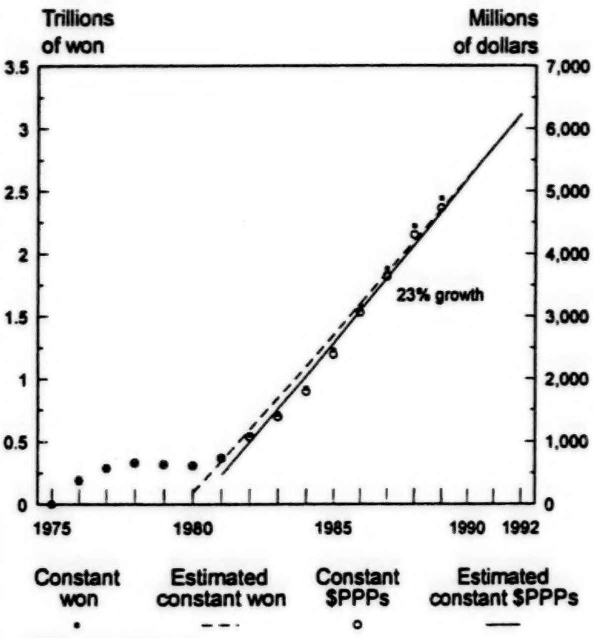
NOTE: See table A-18.

Figure 37. Growth in R&D in Singapore: 1975-92



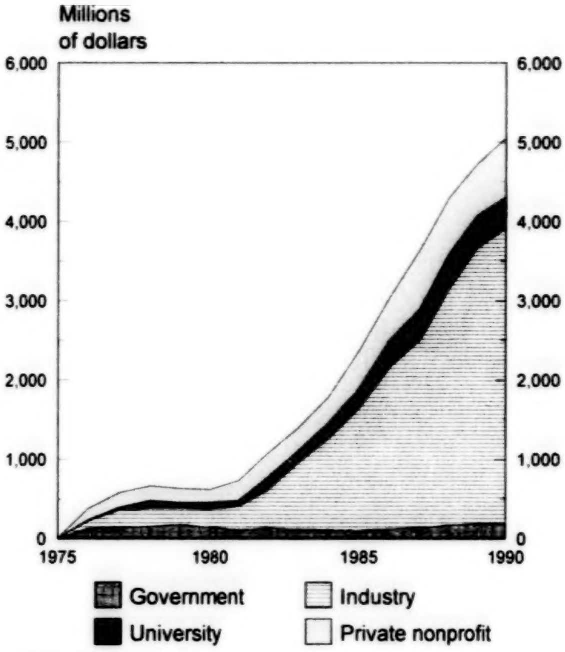
NOTE: See table A-16

Figure 38. Growth in R&D in South Korea: 1975-92



NOTE: See table A-16.

Figure 39. R&D in South Korea, by performer: 1975-90



NOTE: See table A-18.

South Korea's overall R&D investment went from 60 billion to 3.2 trillion won over the period 1975–90. In dollars, this is equivalent to an investment growth from $378 million in 1976 to $5 billion in 1990. The average annual growth rate in R&D expenditures was around 23 percent over the 15-year period, as shown in figure 38.

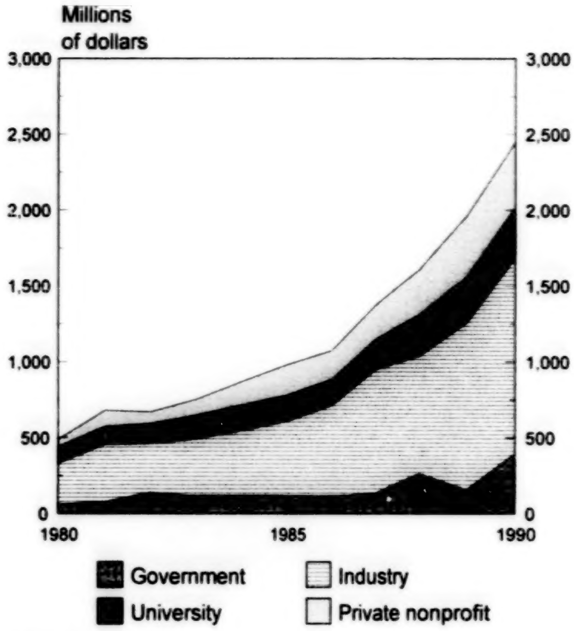
As in Japan, industrially funded R&D in South Korea is growing faster than overall R&D. South Korea went from an annual investment of $133 million in 1976 to an annual investment of $4.2 billion in 1990. This is an average annual growth of 26.2 percent. At this rate of growth, the annual expenditures would reach $5.2 billion in 1992, one-tenth of Japan's industrially supported R&D. South Korean firms have shown an ability to adapt foreign technologies, acquired through licensing agreements, to their production requirements. This would not have been possible without their R&D capability. Half of the approximately 1,000 research institutions in South Korea are in private industry and half of these are heavily concentrated in the 10 largest *chaebol* (industrial conglomerates), particularly the electronics and chemical industries. The growth in industrially performed R&D is shown in figure 39.

Taiwan

Relative to South Korea and Japan, Taiwan's smaller business enterprises do not invest heavily in R&D. They do, however, join forces to conduct combined research for innovative products. Figure 40 shows Taiwan's R&D by sector of performance.

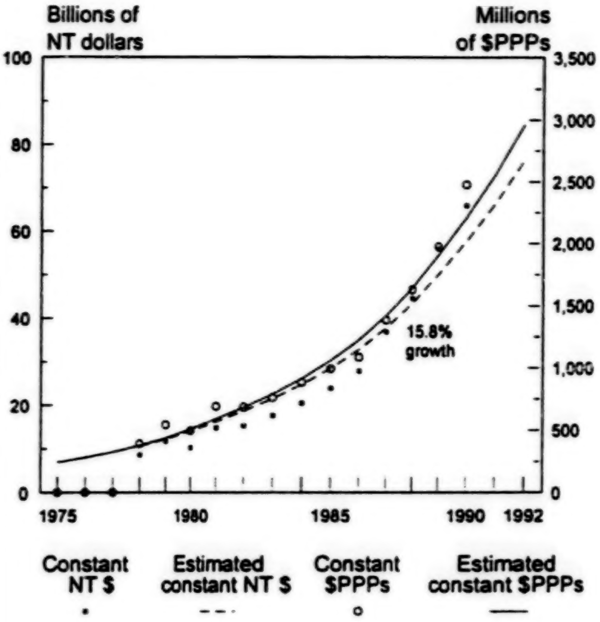
The Government established the Industrial Technology Research Institute (ITRI) in the 1980s to compensate for the small firms' lack of R&D participation. Working through ITRI and other institutions, the Government has boosted R&D spending to 1.7 percent of GDP. Under ITRI, 20 companies joined to successfully make IBM-compatible computers. ITRI's Electronics Research and Service Organization is joining with 47 Taiwanese companies to develop notebook computers. Taiwan's "Silicon Valley" is the Hsinchu Science-based Industrial Park, established in 1980 to benefit from the interaction between foreign

Figure 40. R&D in Taiwan, by performer: 1980-90



NOTE: See table A-18.

Figure 41. Growth in R&D in Taiwan: 1975-92



NOTE: See table A-16.

high technology investment and technology transfer, dynamic R&D consortia, and Taiwan's expanding higher education system in S&T.

Taiwan's overall R&D investment went from 6 to 71 billion New Taiwanese dollars from 1978 to 1990. In dollars, this is an investment growth from $388 million to $2.4 billion, as shown in figure 41. If Taiwan is able to maintain this 15 percent annual growth rate, it will be spending about $2.9 billion in R&D in 1992, approximately equal to the annual budget of the National Science Foundation.

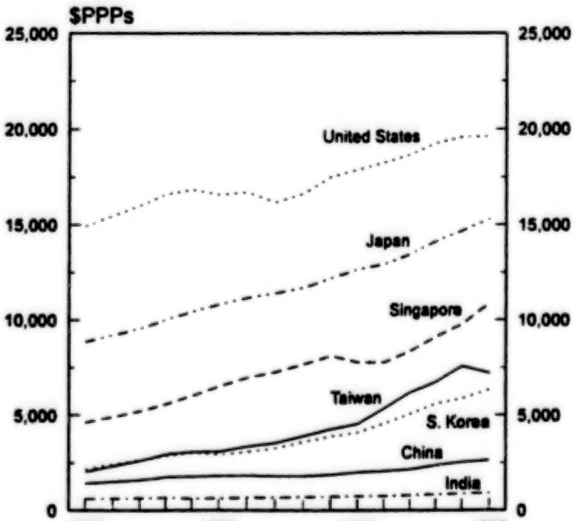
6. Gross Domestic Product by Country

The economies of the six countries studied for this report have flourished, allowing for the very high growth rates in research and development (R&D) investment and precipitating the need for an ever-more talented labor force. The per capita gross domestic product (GDP) has doubled in South Korea and Singapore over the last 15 years, and tripled in Taiwan. Japan's per capita GDP has increased by one-third. See figure 42.

China

China's GDP grew from 358 billion yuan in 1978 (in current national currency) to 1.7 trillion yuan in 1990, a growth rate of 14.9 percent. In purchasing power parity dollars ($PPPs), this is equivalent to increasing from $1.6 trillion to $2.9 trillion, as shown in figure 43. The GDP growth rate in constant currency has been more than 6 percent since China opened up to the West in 1982; 4.9 percent over a 12-year period. This growth has been fueled by exports to U.S. open markets, which reached $15 billion in 1991. One growth industry in the Fujian economic zone has been the assembly of semiconductors, with Taiwanese companies entering China for lower costs and the supply of highly educated engineers. Another economic zone in Guangdong, across from Hong Kong, draws in foreign capital, companies, and expertise. By 1991 there were 37,000 joint venture enterprises and 28 economic development zones.

Figure 42. Per capita GDP in selected Asian countries and the U.S.: 1975-90



NOTE: See tables A-14 and A-22.

India

India's economy has grown from 790 billion rupees in 1975 (in current national currency) to 5.2 trillion rupees in 1990. In 1990, its GDP was equivalent to $770 billion. In constant currency, the Indian economy grew at 5 percent in the last 15 years, as shown in figure 44.

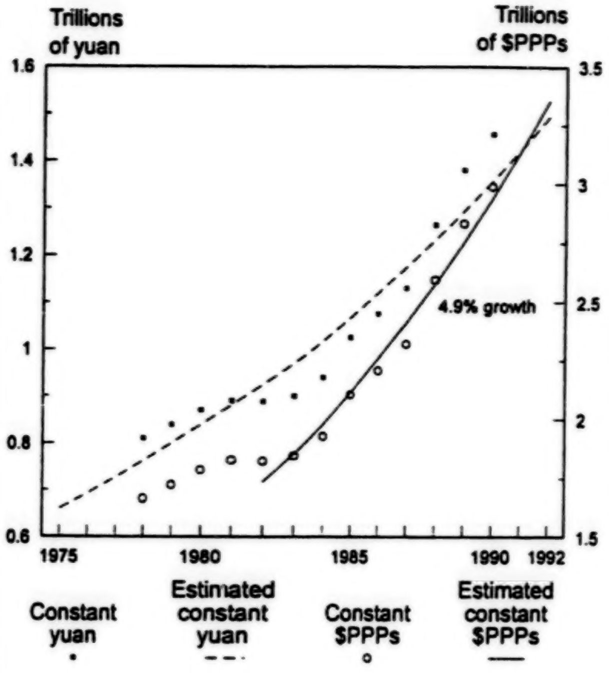
In 1991, India made a substantial shift toward a more liberal economic policy on direct foreign investments. Joint ventures may now have up to 51 percent foreign equity participation, and many have been quickly approved by the Government. For example, IBM, which left India in 1977 because of restrictive policies, is now returning in a 50–50 joint venture with the Tata Group to produce personal computers and software packages for exports as well as for sale to the local market (United Nations 1992).

However, there is still no large-scale investment from abroad nor any big jump in exports. A balance of payments crisis was triggered by the collapse of the Soviet Union, India's main trading partner, and the impact of high oil prices during the Gulf War. India is undergoing a program of structural reform, closing down financially draining State industries, providing infrastructure and telecommunications, lowering tariffs, and bringing the deficit under control. Austerity measures introduced in 1991 resulted in a GDP growth rate of only 2 percent that year.

Japan

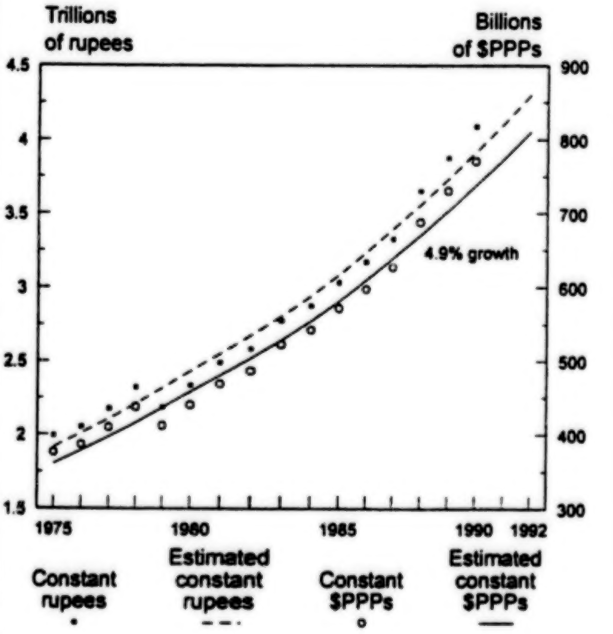
Japan's economy grew from 148 trillion yen in 1975 to 415 trillion yen in 1990 (in current national currency), with a growth rate of 6.6 percent. In dollars, this is equivalent to a $1.9 trillion economy in 1990, with a growth rate of over 4 percent in constant currency, as shown in figure 45. Japan has approximately the same percentage of GDP invested in R&D as does the United States (2.9 and 2.8, respectively), but Japan's economy has more heavily invested in new plant and equipment throughout the 1980s. Japan's GDP growth rate is slowing, but the country will still reap the benefit to productivity improvement of this heavy

Figure 43. Growth in GDP in China: 1975-92



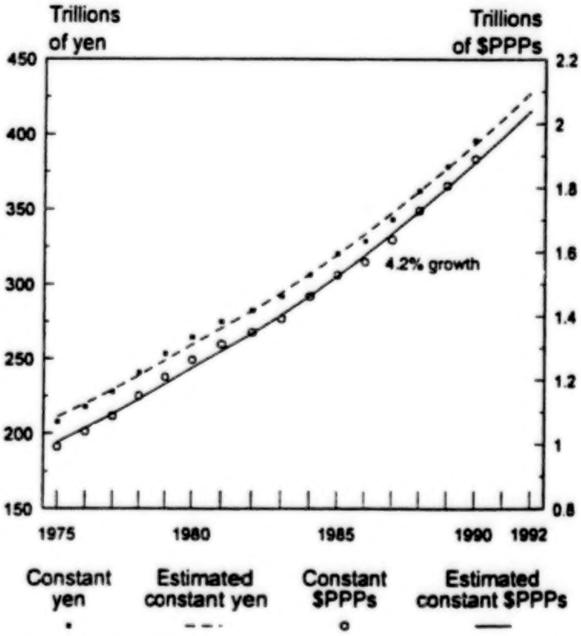
NOTE: See table A-22.

Figure 44. Growth in GDP in India: 1975-92



NOTE: See table A-22.

Figure 45. Growth in GDP in Japan: 1975-92

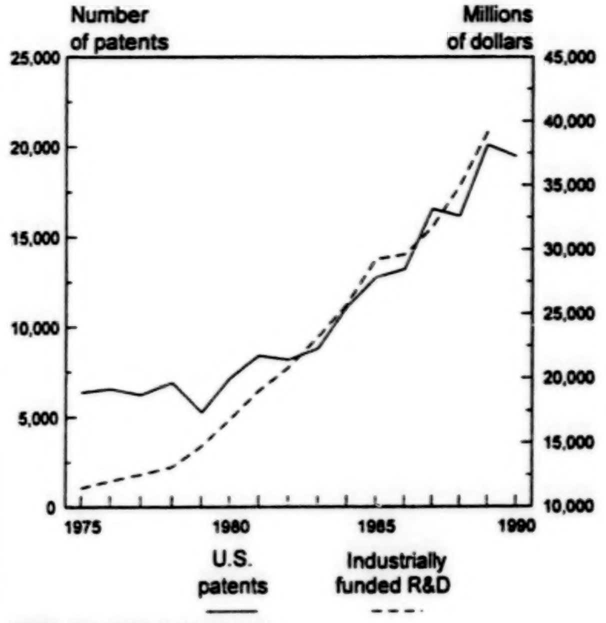


NOTE: See table A-22

investment in modern industrial processes and infrastructure.

Japan's investment in industrially funded R&D correlates with the number of U.S. patents granted over the last 15 years, as shown in figure 46.

Figure 46. Industrially funded R&D and U.S. patents granted to inventors from Japan: 1975-90

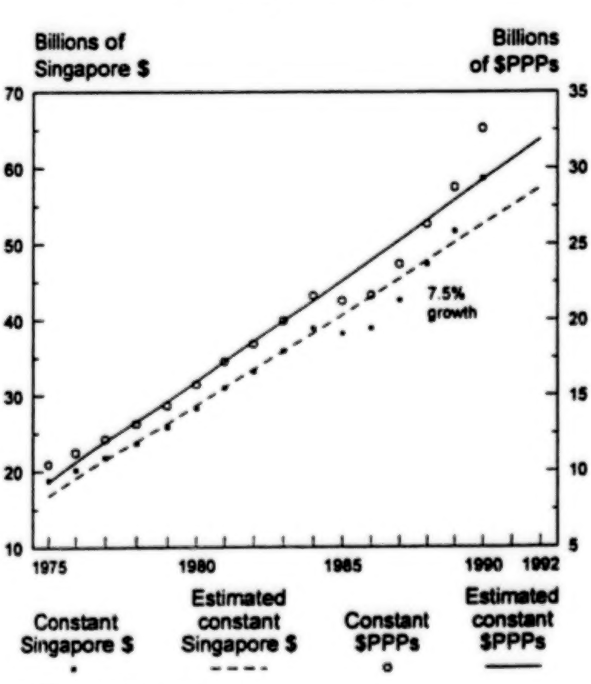


NOTE: See tables A-17 and A-21.

Singapore

Singapore's economy grew from 13 to 64 billion Singapore dollars (in current national currency) between 1975 and 1990, with a growth rate of more than 10 percent. In dollars, this is equivalent to $26 billion in 1990, with a growth rate of more than 7 percent, as shown in figure 47.

Figure 47. Growth in GDP in Singapore: 1975-92



NOTE: See table A-22.

About 17 percent of Singapore's GDP is based on production of information technology hardware. Singapore wants to be a computer information-based economy in the near future and has invested in people and research centers to facilitate this shift. Singapore has outstanding researchers in information systems and computer science, many of whom received doctoral training in the United States. The National University of Singapore is cited as one of the centers of excellence in Southeast Asia where significant research is being done, of as high a quality as U.S. research in areas of data base systems and design automation (Kahaner 1992). The U.S. National Science Foundation (NSF) has established, with Agency for International Development funding, information-education exchange linkages among NSF-funded university research centers and these Singapore research centers. The University of Pittsburgh's Parallel, Distributed & Intelligent Systems Center will link with the Institute of Systems Science of the University of Singapore, and Carnegie Mellon's Data Storage Systems Center will link with the University of Singapore's Magnetic Technology Center (Lepkowski 1992).

South Korea

The South Korean GDP has grown from 10 to 142 trillion won (in current national currency) over the last 15 years, with a 19.8 percent growth rate. In dollars, this is equivalent to a $248 billion economy in 1989, with a growth rate of more than 8 percent, as shown in figure 48. South Korea is now a net exporter of foreign direct investments.

South Korea's investment in industrially funded R&D correlates with the number of patents granted over the last 15 years, as shown in figure 49.

Taiwan

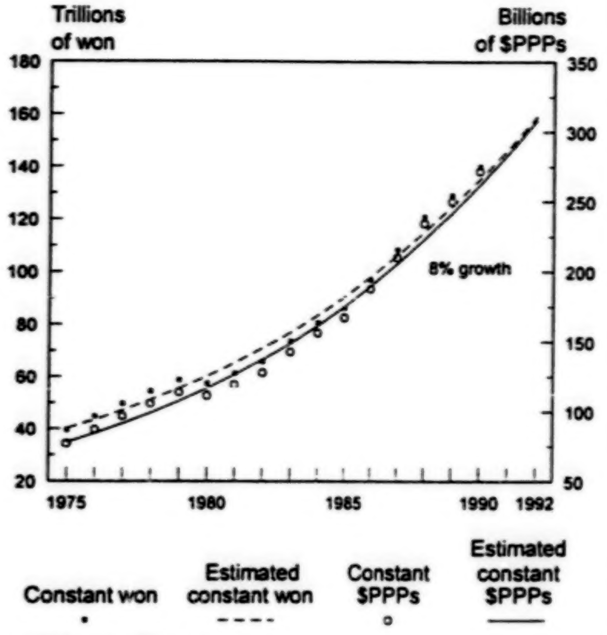
Taiwan's GDP grew from 590 billion to 4 trillion New Taiwanese dollars (in current currency) over the 15-year period, with a growth rate of 14.2 percent. Taiwan has been exporting far more than it imports since the early 1980s, particularly electronics, computer chips, machinery, and textiles, and reached a trade surplus of $13 billion in 1991.

In dollars, Taiwan had a $146 billion economy in 1990, with a growth rate of more than 10 percent, as shown in figure 50.

In trying to upgrade industry and acquire foreign technology, Taiwan is entering joint ventures with U.S. companies. Its large financial reserves are also being used for investments in developing countries, exceeding $5 billion in Malaysia since 1987. Currently focusing on China, Taiwan is investing in setting up factories, not just in the southern economic development zone of Guandong Province. The bulk of Taiwan's investment is in Fujian Province, where high technology firms are located, but investments are also being made in other Provinces. No longer necessarily using Hong Kong as a third party for investment, Taiwan can now make direct investments in China. Taiwan's exports to the United States have recently fallen, but Taiwan is developing its China market. There are many more open exchanges of science and engineering delegations between China and Taiwan.

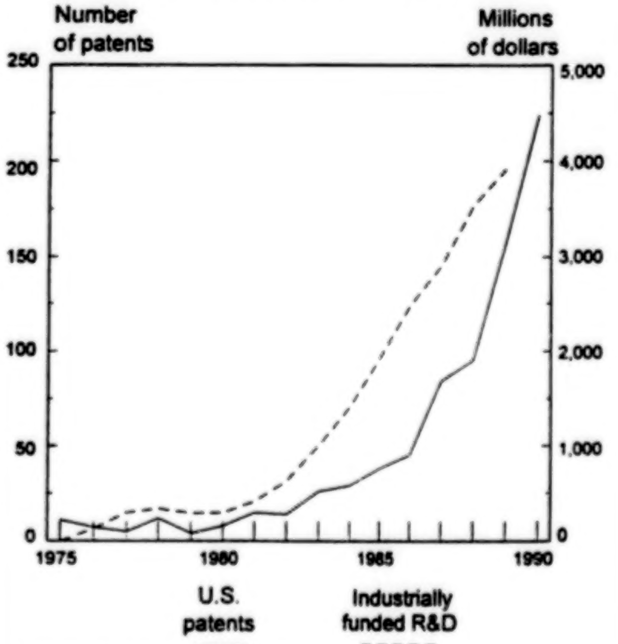
Taiwan has a large number of patents relative to the small amount of industrially funded R&D, as shown in figure 51. The Director of the Planning and Evaluation Division of Taiwan's National Science Council explained some of the reasons for this imbalance: Because many electronic consumer items are sold in the United States, Taiwan is very careful to register all patents to avoid lawsuits with the United States. Additionally, the Industrial Technology

Figure 48. Growth in GDP in South Korea: 1975-92



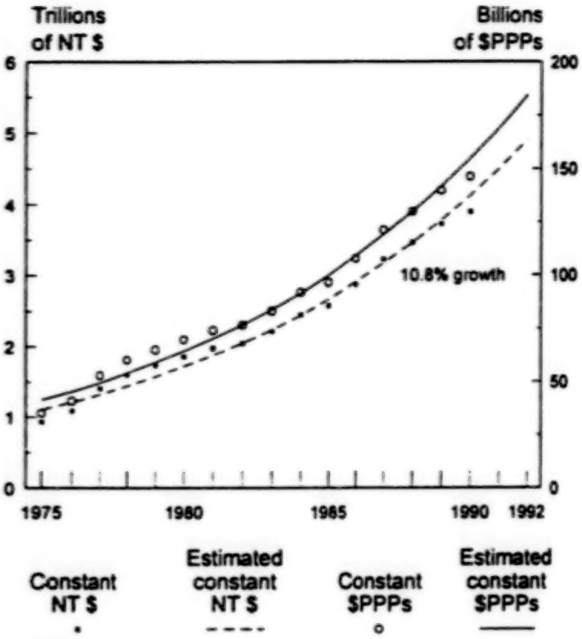
NOTE: See table A-22.

Figure 49. Industrially funded R&D and U.S. patents granted to inventors from South Korea: 1975-90



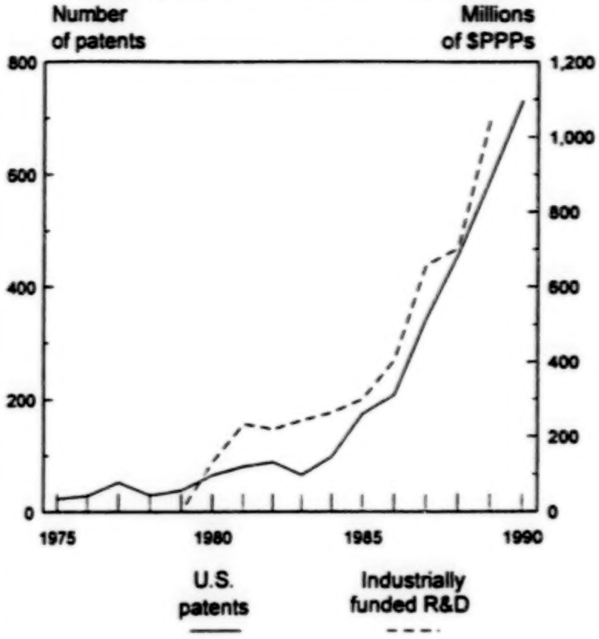
NOTE: See tables A-17 and A-21.

Figure 50. Growth in GDP in Taiwan: 1975-92



NOTE: See table A-22.

Figure 51. Industrially funded R&D and U.S. patents granted to inventors from Taiwan: 1975-90



NOTE: See tables A-17 and A-21.

Research Institute (ITRI) evaluates R&D programs it funds by patents, so researchers are encouraged to patent their ideas.

To accelerate industrial research and innovation, Taiwan's recent National Development Plan provides $18 billion in funds for speeding up technology development and increasing R&D. Since Taiwan sees its future economic success in moving away from hardware to software and in developing future markets, it will establish a software industrial park to accelerate the development of specialized areas in a domestic software industry.

7. Prospects for the Future

Will the production of scientists and engineers in the six Asian countries studied be sufficient to meet future needs of this dynamic world region? How this question is answered will be important for scientific, technological, and educational policies of these countries and will have consequences for related policies in other regions of the world, such as the effect on supply in countries that depend on immigration of scientists and engineers from these regions.

Many Asian countries are concerned about the adequacy of their supply of scientists and engineers. The following section discusses assessments of the scientific workforce from the perspective of the countries in the region. It also discusses some of the policies and programs being put into place in these countries in order to address their perceived demand for scientists and engineers.

Japan has been concerned about an adequate supply of scientists and engineers because of the decline in the number of 20- to 24-year-olds. The Japan Science and Technology Agency (STA) has been trying to estimate future supply and demand for numbers of research scientists and engineers (RSEs). In one initial study it commissioned, a simple regression model was used to estimate demand as a function of real gross domestic product (GDP) and supply as a function of the population of the labor force (Nagata n.d.).[13]

The methodology of the above study utilizes various projections of GDP and the size of the labor force for future years. Using this simple regression, future estimates for the demand for RSEs were computed to present two possible demand and supply scenarios, one for continued GDP growth of 4 percent, and one for a lower GDP growth of 3 percent. Under both of these scenarios, there appeared to be a problem in meeting the necessary supply.

Although a precise estimate for demand is difficult to determine, Japan is already implementing policies to avoid a possible gap in supply and demand for RSE. Japan's new science and technology (S&T) policy calls for simplifying administrative work so that researchers can concentrate more on R&D, encouraging female participation, and allowing the elderly to continue working.

A key part of this policy is to attract researchers from all over the world and intensify cooperation in cultivating human resources with countries in the Pacific Rim (Government of Japan, Cabinet Decision 1992). Japan is also expanding employment and fellowships for foreign researchers. *Science* magazine recently reported that about one-third of the graduate students in Japanese university laboratories are Chinese (Myers 1992) and, in 1991, 40 percent of all of Japan's doctoral students in engineering came from overseas.

Singapore, South Korea, and Taiwan also report projected labor shortages in 1992 (Low 1992). With greater prospects of direct foreign investment flowing across the Pacific Rim, there will be higher demand for scientists and engineers as well as for administrative and managerial personnel.

Singapore faces a labor shortage at all skill levels. Foreign workers allowed into the service sector number 200,000–250,000, or about 15 percent of the total labor force. Singapore's drive toward restructuring the economy to high technology exports has required tapping skilled labor from South Korea,

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[13] This is only one approach used in Japan's analysis of future science and engineering labor markets. The Japanese Government is planning a major new study to determine the current and future supply of scientists and engineers in its labor force.

Taiwan, Hong Kong, and China. Singapore has been successful in recruiting 60 doctorate holders from China for new research institutes in its science park (Wong 1992), but still lacks the critical mass of trained doctorate recipients to do original research.

South Korea has a labor shortage in highly skilled workers and technicians and a decline in the size of the absolute labor force. In Taiwan, the service sector has become the main employment sector, increasing the need for professional and technical workers (Low 1992). These countries, like Japan, are implementing policies to avert a lack of RSEs in the 1990s. South Korea is rapidly expanding graduate education to overcome the shortage of high-level personnel trained beyond the bachelor's level. To further upgrade the labor force, the Korean Government is expanding programs to send students abroad. The Korean Science and Engineering Foundation (KOSEF) has an enlarged scholarship program to allow some 10,000 science and engineering (S&E) students to receive postdoctoral training abroad by the year 2000.

In addition, the Government has attracted Korean scientists and engineers who had been living abroad back to South Korea, as salaries and living and working conditions have improved. In the late 1960s, South Korea recruited 300 experienced and new doctorate holders with very attractive positions and salaries in a Battelle-type research institute, the Korea Institute of Science and Technology (KIST). Five years later, a similar recruitment successfully brought back 300 S&T personnel to be faculty in the Korean Advanced Institute of Science and Technology (KAIST). In the late 1980s, POSEK, an S&T institute modeled after the Massachusetts Institute of Technology, convinced 200 Koreans with doctorates working in the United States to come back. POSEK is the second most prestigious teaching institute after the Seoul National University (Hong 1992).

Taiwan makes a concerted effort to attract back S&T personnel educated in the United States. Its Manpower Planning Department assesses required manpower with advanced degrees for strategic industries, plans for recruitment from abroad, and designs the expansion of S&T university education in Taiwan. The pay scale for high-level experts is made attractive and the equipment and research environments of S&T departments at universities are improved. During the period 1976–91, the number of S&T returnees registered by the Government's Youth Employment Service Agency increased from 393 to 1,157. A far greater number return for employment without the assistance of this agency. National Conferences on Science and Technology are often held in Taiwan to establish channels of communication with overseas scholars so they can be recruited more easily when their services are needed. The National Six Year Plan for S&T Development 1991–1996 includes a Project for the Development, Recruiting, and Utilization of S&T Human Resources. The Plan also calls for 25 new universities to increase S&T higher education, expand graduate education, and improve S&T instructors at all levels of education (Chang 1992, p. 8).

China's Ministry of Personnel has a 10-year program for developing human resources for an export-oriented economy in coastal and river areas. One such area, the city of Shanghai, has 30,000 S&T personnel, but estimates a need of 90,000 by 1995 (Shengyun 1992). One obstacle to China's export-oriented economic development is the severe lack of qualified personnel with the required knowledge and technical ability. To overcome this, China will strengthen on-the-job training, greatly expand special fields of study, and encourage the return home of students studying abroad.

Given its very high production of natural science doctorates, India will have many more graduates than could be hired by its research community. If China and India are able to maintain their level of production of S&E graduates in the next several years, they may be able to provide the research personnel in demand in other Asian countries in the next decade. The difficulty for China will be to continue producing more scientists and engineers for rapid economic development while moving slowly in the political arena. Although waves of reform have allowed goods and capital to move relatively freely around China, labor does not follow the rules of the market, but rather the rules of the state bureaucracy. "[F]or the most part, people still need formal permission to move from place to place" (Survey of China 1992, p. 8).

Needs for Further Research

More research must be performed in each of the areas covered in this report to develop a complete analysis of the S&T human resources situation in the Asian region. For example, more data are needed on China's stock of S&E personnel, as well as on China's quantitative accomplishments in strengthening S&T education for economic development and its technically qualified cadre of young professionals. Attention should be given to the interrelationships between Asian S&T capacity and higher education training in other countries, especially the United States. How big a role do Asian-born U.S.-trained scientists who are working in the United States play in Asian S&T development? Further study should also explore mobility among these Asian countries and throughout the world for graduate degrees in S&E and research employment in industry, government institutes, and universities. In 1991, Japan received 41,000 students from the Asian region for university and advanced education, the United States about 230,000. Further research is needed on how Japan is changing to make its universities accessible and to transfer technology and engage in cooperative technology development. The extent to which Japan will look to China, India, and Russia for tapping the S&E pool has implications for the supply to the United States and the producing countries.

The effect of contact of S&E personnel from China and India with the smaller dynamic Asian economies in getting research activities out of government research institutes and into industrial enterprises should also be studied. In particular, interaction between mainland China and Asia's newly industrialized economies (NIEs) with linguistic and cultural similarities (Singapore, Hong Kong, Taiwan, and Malaysia) should be studied to see how the NIEs' knowledge of markets, contribution of venture capital, and managerial talent will facilitate China's manufacturing, financial, and marketing capabilities.

More research is needed on the factors contributing to economic growth in the region including the effects of various national strategies for economic growth, e.g., policies toward foreign direct investment and import substitution. Of particular interest to Western countries is to examine the path of open markets taken by some Asian economies (Hong Kong, Taiwan, Singapore, South Korea, and recently India). More work is needed on developing the methodologies and data necessary for estimating supply and demand for scientists and engineers in all countries.

Since many S&T initiatives in Asian nations are similar (e.g., information industry, advanced materials, biotechnology), the particular scientific strengths and the research niche of each country should be assessed in regional and international scientific workshops. Scientists and engineers should identify opportunities for increased collaboration with the United States and with each other that would blend strengths in both research and product development.

Implications for the United States

The following conclusions can be drawn from this study:

- The six Asian countries studied will continue to use the U.S. higher education system. The sharp jump in the value of Asian currencies relative to the dollar has greatly increased the number of Asian students with the financial capacity to study in the United States, and will continue to do so. The countries' continued expansion of graduate education in science and engineering does not decrease their need for overseas study. China has begun a "self-reliant" effort to educate doctoral students within China, possibly because the majority educated in the United States remain here (see table 10). However, the need for foreign and domestic education grows together (Cummings n.d.). These Asian countries cannot meet the demand for quality higher education fast enough nor can they staff new or expanded domestic institutions without relying on graduate training abroad, often in the United States.

- Foreign graduate student enrollment in U.S. universities and preference for natural science and engineering (NS&E) degrees will help to maintain U.S. doctoral programs' emphasis in these subjects. Doctoral programs in S&E fields in the United States have grown relatively faster than in non-S&E fields. Between 1975 and 1990, the ratio of NS&E degrees to total doctoral degrees in the United States increased from 35 to 45 percent. Since Asian foreign graduate students come mainly for science and engineering fields, they are and will continue to be an integral part of U.S. universities' S&E strengths.

- These Asian countries will begin to challenge the United States for the S&T personnel educated in U.S. universities for their own high technology economies. Asians have accounted for more than half of all scientists and engineers immigrating to the United States between 1970 and 1985 and were still over half in 1988 (National Science Foundation 1986 and 1990). In 1988, about 3,600 Asian scientists and engineers were certified for entry visas (including temporary visas) by the U.S. Department of Labor; twice as many may receive entry by relatives rather than by certification and eventually work as scientists and engineers in the U.S. labor force. In 1991, more than 2,600 new Asian doctorate holders in S&E from U.S. universities planned to stay in the United States (see table 10).

  However, since the Asian region will be an economically and scientifically important area needing S&E personnel, these Asian countries will be increasingly attractive to their students who have academic and industrial experience in the United States (Pedersen n.d.). Taiwan and South Korea have been particularly successful in attracting their students to return, offering large incentives to start companies in critical technologies. (Table 10 shows the decreasing percentage of Taiwanese and Koreans who plan to stay in the United States.)

- Continued linkage with Asian scientists and engineers trained in the United States through international S&T collaboration would foster a free flow of RSE personnel between the East and West. U.S.-trained Asian scientists and engineers are our natural counterparts in international collaboration.[14]

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[14] For areas of scientific excellence in Asia, see the quarterly publication *Scientific Information Bulletin* of the Office of Naval Research, Asian Office, Unit 45002, APO AP 96337-007. The Tokyo Office of the National Science Foundation has reports available on STIS, NSF's on-line Science and Technology Information System.

Table 10. Asian doctoral recipients in natural science and engineering from U.S. universities who plan to stay in the United States: 1980, 1990, and 1991

Country	Total (1)	Plan to stay (2)		Firm plans to stay (3)	
		Number	Percentage	Number	Percentage
		1980			
China (4)	280	157	56.1	131	46.8
India	339	248	73.2	201	59.3
Japan	47	19	40.4	13	27.7
South Korea	87	51	58.6	44	50.6
Taiwan	399	255	63.9	214	53.6
Total	1,152	730	63.4	603	52.3
		1990			
China	964	585	60.7	413	42.8
India	630	430	68.3	341	54.1
Japan	75	36	48.0	29	38.7
South Korea	766	271	35.4	200	26.1
Taiwan	931	428	46.0	287	30.8
Total	3,366	1,750	52.0	1,270	37.7
		1991			
China	1,520	1,265	83.2	778	51.2
India	633	496	78.4	364	57.5
Japan	73	32	43.8	23	31.5
South Korea	827	334	40.4	209	25.3
Taiwan	981	539	54.9	313	31.9
Total	4,034	2,666	66.1	1,687	41.8

(1) Total doctoral recipients in natural science and engineering

(2) Doctoral recipients who think they will locate in the United States

(3) Doctoral recipients who have postdoctoral research appointments or academic, industrial, or other firm employment in the United States

(4) China data are for 1987, the earliest year for which data are available.

SOURCE: National Research Council 1992

8. Methodology and Notes on Data Series

International Data

UNESCO Data

Dr. Morton Brown of the Division of Statistics of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) provided the National Science Foundation (NSF) with available data on enrollments and graduates in six fields of science and engineering, by gender, for more than 150 countries for the time period 1975–88. The fields of study (i.e., a student's main area of specialization) were as follows:

- social and behavioral science
- natural science
- math and computer science
- engineering
- agricultural science
- medical science (medical science data were not used in this report)

Dr. Brown provided data in these fields by level of programs. The definitions used for program levels are based on the International Standard Classification of Education (ISCED) and are as follows:

Level 5: Programs leading to an award not equivalent to a first university degree. Programs of this type are usually practical in orientation in that they are designed to prepare students for particular vocational fields in which they can qualify as high-level technicians, teachers, nurses, production supervisors, and the like.

Level 6: Programs leading to a first university degree or equivalent qualification. Programs of this type comprise those leading to typical first university degrees, such as a bachelor's degree or a license, or to first professional degrees such as doctorates awarded after completion of studies in medicine, engineering, or law.

Level 7: Programs leading to a postgraduate university degree or equivalent qualification. Programs of this type generally require a first university degree or equivalent qualification for admission. They are intended to reflect specialization within a given subject area.

ISCED program levels do not guarantee comparability of degrees across countries.

The degree data were verified country by country through national education statistics. See National Data for each country below or the bibliography for source documents. Educational statistics for each country were reconfigured to the NSF classification of fields of science. American and foreign scholars familiar with higher education in each country translated documents and reconfigured university departments' statistics to the NSF classification of fields of study in the Integrated Postsecondary Education Data System (IPEDS).

Demographic Data

UNESCO's Division of Statistics provided demographic data by age segments for all countries.

Dr. My T. Vu, a demographer with the World Bank, provided data files for China, India, Japan, Singapore, Korea, and Hong Kong from the forthcoming 1992 edition of *East Asia and Pacific Region, South Asia Region Population Projections* (Bos, Vu, and Levin 1992).

Mr. Charles Peng provided demographic data on Taiwan from the *Statistical Yearbook of the Republic of China* (Government of the Republic of China, National Science Council 1989).

GDP Data

National accounts time-series data for gross national product (GNP), gross domestic product (GDP), and deflator and exchange rates for 1975-90 were obtained from the International Monetary Fund's *International Financial Statistics Yearbook* for 1990, 1991, and 1992 (International Monetary Fund 1990, 1991, 1992).

University of Pennsylvania "Penn World Tables"

Current national currencies were converted to constant 1987 national currencies and then converted to 1987 constant purchasing power parities ($PPPs) using the University of Pennsylvania World Tables of International Price Comparisons, developed by Dr. Alan Heston and Dr. Robert Summers.

The "Penn World Tables" are based on the United Nations International Comparison Program (ICP) empirical benchmark studies conducted in 1970, 1975, 1980, and 1985. The ICP studies are pricing exercises of identically specified goods and services to estimate price parities for each country's currency and an overall purchasing power parity that makes real comparisons across countries possible. For countries that are not part of the ICP studies, Heston uses post allowance estimations of the Department of State for comparative prices.

The underlying work for $PPPs has been for particular outputs, e.g., food, clothing, and services. No $PPPs exist for inputs; neither is there a specific $PPP for research and development (R&D). Using the overall $PPP will not be perfect, but it is much preferable to using the official exchange rate to compare R&D across countries because the latter measure is volatile and would be very misleading. Most international organizations (e.g., the European Community, the Organisation for Economic Co-operation and Development [OECD], and the United Nations Development Program) and some governmental organizations (such as the Agency for International Development) now extensively use $PPP-based comparisons. Planned economies are not formal members of the ICP project. Price samples are from other sources.

National Data

China

Education data. UNESCO enrollment and graduate data were verified with the estimates made by Dr. Leo Orleans, a China scholar at the Library of Congress. It is Dr. Orleans' opinion that the UNESCO figures for Chinese students and degrees are conservative, not inflated. No attempt was made to derive estimates for the early missing years (1975–81) because the quality of the worker-peasant-soldier-scholars admitted to Chinese universities in the 1970s would not be comparable to students in other countries.

Known uncertainties in R&D data. The first R&D survey of 1985 showed how hard it was to capture R&D expenses from the extensive system of R&D institutes built in the 1950s. With the "Great Leap" of 1958, scientists were encouraged to learn the science, technology, and production wisdom of the masses, and R&D was decentralized. Scientists and engineers in R&D came under the control of "work units."

For the 1985 R&D survey, then, central and local governments had to cooperate to have data come up from these work units and there is a lack of consistency in the concept of R&D at each level. The State Education Commission, which has a strong desire to produce accurate, internationally comparable statistical data, uses a strict definition of R&D in its survey of R&D in the universities. The State Science and Technology Commission collects data from Government research institutes in the natural and social sciences (county, local, ministerial, the Chinese Academy of Science, etc.). Its reports, entitled Science and Technology Statistics, are not yet fully comparable to international standards. The Science and Technology Department of the State Statistical Bureau collects R&D information on large and medium-sized enterprises. By 1988, the annual White

Paper incorporated data from all three of these sources.

China would like to capture R&D expenditures in its surveys and then corroborate these numbers through national budget data. There are many problems to overcome. There are major sections in the national budget for health, education, science, and culture, but no one knows what the R&D component is. The State Statistical Bureau uses the concept of technological development, which can include science and technology (S&T) administration projects and S&T services.

R&D data on China were obtained from Richard P. Suttmeier (1990b) and from Mr. Zhao Yuhai of the Division of Statistics, Department of Planning, State Science and Technology Commission, in a seminar he gave at NSF in April 1991 and in follow-on correspondence in May 1991.

GDP data. Dr. Jeffrey Taylor, formerly of the Bureau of Census, International Statistical Programs Center, and currently with the China Branch of the International Monetary Fund (IMF), recommended computing GDP and deflators from the original source, the *Statistical Yearbook of China* (Government of the People's Republic of China 1991), instead of from the IMF figures. GDP was computed from the values given for the primary, secondary, and tertiary sectors of the Chinese economy. The deflator was rebased from 1978 to 1987, and the Penn World Tables were used to convert constant yuan to constant $PPPs.

India

Education data. UNESCO had received only 2 years of enrollment and graduate data on India: 1974 and 1978. Dr. A.R. Rajeswari of the Department of Science and Technology in India provided data for 1947–83 from the Survey of the Council of Scientific and Industrial Research. More recent data—for 1974, 1979, and 1984–86—were reported in the *Pocket Data Book, 1991* (Government of India, Department of Science and Technology 1991). At NSF's request, the Department of Science and Technology supplied 1987 degree data. Social science data are not included and math and computer science are included in natural science.

Known uncertainties in R&D data. The higher education sector has traditionally not been surveyed in R&D statistics that have come out since 1973. There are 8,000 colleges in India and it was difficult for academic staff to apportion time between research and teaching to classify clearly the human resources employed for R&D and auxiliary activities. It is also considered too difficult to provide data on R&D expenditures. Recently, however, India's Institute of Applied Manpower Research (1991) has published its first survey, sponsored by the Government's Department of Science and Technology. Data on social science research are not collected, social science research is not included in the overall R&D figures for India, and social scientists are not included in S&T human resources statistics.

GDP data. These data were obtained from the Government of India's Central Statistical Organization (1991).

Japan

Education data. Mr. Toshio Kudo, a Fellow in the Japan Program of the NSF Division of International Programs, provided line by line translation of all fields of science included in the six categories, requested and received a detailed written explanation of how Monbusho data are reported to UNESCO, and requested and received the detailed *Monbusho Survey* of higher education for the years 1975-90 (Government of Japan, Ministry of Education, Science, and Culture 1975–90).

Japanese enrollment and graduate data are submitted to UNESCO from the *Monbusho Survey*. UNESCO requests that the Ministry disaggregate math and computer science from natural science, so Japan reports them separately to UNESCO but aggregates them for its national statistics. UNESCO also requests that agricultural engineering be included in engineering. For national statistics, the Government reports it as an agricultural science. NSF made one further adjustment to the Japanese data: Agricultural economics was subtracted from agricultural science and added to social science.

R&D data. R&D data for Japan were obtained from the Government of Japan's Statistics Bureau, Management and Coordination Agency (1991) and Science and Technology Agency (1991a).

Adjusted data in R&D. The Organisation for Economic Co-operation and Development (OECD 1992) provided adjusted Japanese data (line 26 in each OECD table) below the reported Japanese submission (line 13). The adjustments convert head counts of research scientists and engineers (RSEs) to full-time equivalents (FTEs). The adjusted data still appear in OECD 1992 with the notation (L), "Overestimate," because the head count reported by industry has not yet been converted to FTEs.

The OECD adjustments cause a reduction in Japanese overall R&D of 8 percent and a reduction of overall RSEs by 20 percent. Industrial reporting of FTEs and industrial R&D is not adjusted. University-performed R&D is reduced by 45 percent. In other NSF reports, the numbers used for Japanese R&D scientists and engineers have been adjusted by using only natural scientists and engineers. Therefore, the data differ somewhat.

Singapore

Education statistics. Dr. S. Gopinathan, Director of the Comparative Education Center, National University of Singapore, provided University Annual reports on graduates.

R&D data. R&D data were obtained from the Government of Singapore's Science Council of Singapore (1984–85 and 1987–88) and National Science and Technology Board (1990).

South Korea

Education data. South Korean data submitted to UNESCO cover the years 1975–77 and 1980–89. They were verified against Korean Ministry of Education data, with the assistance of the Education Attache. Education data on enrollments and graduates are contained in the *Yearbook of Educational Statistics* (Government of the Republic of Korea 1976–77 and 1983–90). The data disaggregate junior colleges, colleges and universities, and graduate schools. Advanced degrees disaggregate master's and doctoral degrees, and all levels disaggregate gender.

Data reconfiguration was possible for South Korea and Japan because of the level of detail available. Reconfiguration of South Korean data included the following adjustments for comparability with U.S. data:

- In the social sciences, 11 departments out of the 60 listed in the *Yearbook of Educational Statistics* are in fields of science in IPEDS. Anthropology from the humanities list and agricultural economics from the agricultural scientists list are added to the social science total.

- Five departments of math and computer science are subtracted from the natural science total.

- The above five departments from the natural science list and five departments from the engineering list make up the math and computer science list.

- For engineering, seven inappropriate departments (architecture and computer science courses) are subtracted and agricultural engineering is added from agricultural science.

Known uncertainties in enrollment and graduate data. A classification expert, Dr. Stephen Hunt of the National Center for Educational Statistics, assisted in reconfiguring the Korean education data and selected departments comparable to U.S. definitions of these fields of science. However, similar labels for departments may not mean a similar education. For example, one cannot be sure whether industrial engineering in South Korea is engineering technology or a broader and more advanced engineering program. Does South Korea's food science and technology program have a curriculum equivalent to a bachelor's engineering degree in the United States? Does the information processing department have a high or low level of curriculum? Are East Asian Studies, or any area studies program, closer to humanities or social science?

R&D data. South Korean R&D data were obtained from the Government of the Republic of Korea's Ministry of Science and Technology (1990). Missing data on overall R&D and breakdown by type, by source of funds, and by performer were requested and received from the Ministry of Science and Technology through the Korean Science Attache in Washington.

Additional industrially funded R&D information was obtained from Dr. Denis Simon of the Fletcher School of Law and Diplomacy, Tufts University.

Taiwan

Education data. Since no UNESCO data are available on Taiwan, degree data were derived from three documents of the Ministry of Education Statistics, each with different levels of detail on departments of science and engineering. The most detailed information by department and subdiscipline was contained in the *Educational Statistics of the Republic of China* (Government of the Republic of China, Ministry of Education 1982–90) for the years 1987–91. Because this detail was available, Taiwan's science and engineering fields were reconfigured to standard classification of fields of science. More summary degree data were available in annual reports of the Ministry of Education for the years 1982–86, but no standardization of the data was possible. A summary document was used for the years 1976–81 containing department totals only. These documents were obtained from the Coordination Council for North American Affairs for 1982-91. Mr. Charles C.T. Peng provided the translation of fields of science in these educational statistics and obtained the earlier missing years, 1975-81, from the Ministry of Education in Taipei.

R&D data. Mr. Peng also provided the R&D data series from the Government of the Republic of China's National Science Council (1988, 1989).

United States

Education data. U.S. education data were obtained from the Institute of International Education (1991a, 1991b); the NSF (1991, 1992b); and the National Research Council (1992), including special tabulations on postgraduation plans of doctorate recipients in 1980, 1990, and 1991.

R&D data. R&D data for the United States were obtained from the NSF (1992a).

Regression Data

Tables 11 through 13 illustrate the factors used to compute growth in R&D, industrially funded R&D, and GDP.

Table 11. Regressions to compute growth in research and development in selected Asian countries

Page 1 of 2

Current currency			Constant 1987 currency		
India (rupees)					
Constant		–258	Constant		–93
Std Err of Y Est		0.022	Std Err of Y Est		0.028
R Squared		0.99	R Squared		0.91
No. of Observations		5	No. of Observations		5
Degrees of Freedom		3	Degrees of Freedom		3
Growth Rate	14.5%		Growth Rate	5.31%	
X Coefficient(s)	0.135		X Coefficient(s)	0.0517	
Std Err of Coef.	0.007		Std Err of Coef.	0.009	
Japan (1981–89 yen)					
Constant		–151	Constant		–136.065305
Std Err of Y Est		0.000	Std Err of Y Est		0.028
R Squared		0.99	R Squared		0.99
No. of Observations		10	No. of Observations		16
Degrees of Freedom		8	Degrees of Freedom		14
Growth Rate	8.8%		Growth Rate	7.96%	
X Coefficient(s)	0.083		X Coefficient(s)	0.076	
Std Err of Coef.	0.000		Std Err of Coef.	0.001	
Singapore (Singapore dollars)					
Constant		–119603	Constant		–109781.72
Std Err of Y Est		31	Std Err of Y Est		20.95
R Squared		0.97	R Squared		0.98
No. of Observations		10	No. of Observations		10
Degrees of Freedom		8	Degrees of Freedom		8
Growth Rate	25.5%		Growth Rate	21.8%	
X Coefficient(s)	60.40		X Coefficient(s)	55.443	
Std Err of Coef.	3.367		Std Err of Coef.	2.306	
South Korea (won)					
Constant		–563449095	Constant		–497231047
Std Err of Y Est		189567	Std Err of Y Est		123397
R Squared		0.95	R Squared		0.98
No. of Observations		10	No. of Observations		11
Degrees of Freedom		8	Degrees of Freedom		9
Growth Rate	33.9%		Growth Rate	23.3%	
X Coefficient(s)	284531.02		X Coefficient(s)	251173.82	
Std Err of Coef.	20870.66		Std Err of Coef.	11765.44	

Table 11. Regressions to compute growth in research and development in selected Asian countries

Page 2 of 2

Current currency			Constant 1987 currency		
Taiwan (New Taiwanese dollars)					
Constant		–315	Constant		–334.120701
Std Err of Y Est		0	Std Err of Y Est		0.08
R Squared		0.98	R Squared		0.97
No. of Observations		11	No. of Observations		9
Degrees of Freedom		9	Degrees of Freedom		7
Growth Rate	17.8%		Growth Rate	15.9%	
X Coefficient(s)	0.16		X Coefficient(s)	0.171	
Std Err of Coef.	0.01		Std Err of Coef.	0.0107	
Total Asian combined R&D ($PPPs (1))					
			Constant		–161.96
			Std Err of Y Est		0.019
			R Squared		0.99
			No. of Observations		11
			Degrees of Freedom		9
			Growth Rate	9.3%	
			X Coefficient(s)	0.087	
			Std Err of Coef.	0.001	

(1) $PPPs = purchasing power parity dollars

Table 12. Regressions to compute growth in industrially funded research and development in selected Asian countries

[In constant $PPPs [1]]

Page 1 of 2

India		
Constant		–203
Std Err of Y Est		0.079
R Squared		0.97
No. of Observations		16
Degrees of Freedom		14
Growth Rate	11.2%	
X Coefficient(s)	0.105	
Std Err of Coef.	0.004	

Japan		
Constant		–176.630
Std Err of Y Est		0.042
R Squared		0.99
No. of Observations		16
Degrees of Freedom		14
Growth Rate	9.9%	
X Coefficient(s)	0.094	
Std Err of Coef.	0.002	

Singapore		
Constant		–448.723149
Std Err of Y Est		0.114
R Squared		0.98
No. of Observations		12
Degrees of Freedom		10
Growth Rate	25.6%	
X Coefficient(s)	0.228	
Std Err of Coef.	0.009	

Table 12. Regressions to compute growth in industrially funded research and development in selected Asian countries

[In constant $PPPs (1)]

Page 2 of 2

South Korea		
Constant		–937882.546
Std Err of Y Est		84.78
R Squared		0.99
No. of Observations		9
Degrees of Freedom		7
Growth Rate	26.2%	
X Coefficient(s)	473.47	
Std Err of Coef.	10.94	
Taiwan		
Constant		-406.40
Std Err of Y Est		0.097
R Squared		0.96
No. of Observations		8
Degrees of Freedom		6
Growth Rate	23.1%	
X Coefficient(s)	0.207	
Std Err of Coef.	0.015	
Total Asian		
Constant		–193
Std Err of Y Est		0.041
R Squared		0.99
No. of Observations		14
Degrees of Freedom		12
Growth Rate	10.8%	
X Coefficient(s)	0.102	
Std Err of Coef.	0.002	

(1) $PPPs = purchasing power parity dollars

Table 13. Regressions to compute growth in gross domestic product in selected Asian countries

Page 1 of 2

Current Currency			Constant Currency		
			China (yuan)		
Constant		−261.98	Constant		−81.355
Std Err of Y Est		0.070	Std Err of Y Est		0.05
R Squared		0.98	R Squared		0.92
No. of Observations		13	No. of Observations		13
Degrees of Freedom		11	Degrees of Freedom		11
Growth Rate	14.9%		Growth Rate	4.9%	
X Coefficient(s)	0.138		X Coefficient(s)	0.047	
Std Err of Coef.	0.005		Std Err of Coef.	0.004	
			India (rupees)		
Constant		−240.633	Constant		−79.5313
Std Err of Y Est		0.035	Std Err of Y Est		0.035
R Squared		0.99	R Squared		0.97
No. of Observations		16	No. of Observations		16
Degrees of Freedom		14	Degrees of Freedom		14
Growth Rate	13.7%		Growth Rate	4.9%	
X Coefficient(s)	0.128		X Coefficient(s)	0.047	
Std Err of Coef.	0.001		Std Err of Coef.	0.001	
			Japan (yen)		
Constant		−113.18	Constant		−69.83
Std Err of Y Est		0.047	Std Err of Y Est		0.011
R Squared		0.97	R Squared		0.99
No. of Observations		16	No. of Observations		16
Degrees of Freedom		14	Degrees of Freedom		14
Growth Rate	6.6%		Growth Rate	4.2%	
X Coefficient(s)	0.063		X Coefficient(s)	0.041	
Std Err of Coef.	0.002		Std Err of Coef.	0.0006	
			Singapore (Singapore dollars)		
Constant		−6113521	Constant		−4711346
Std Err of Y Est		3199	Std Err of Y Est		2330.94
R Squared		0.96	R Squared		0.96
No. of Observations		16	No. of Observations		16
Degrees of Freedom		14	Degrees of Freedom		14
Growth Rate	10.7%		Growth Rate	7.5%	
X Coefficient(s)	3100.61		X Coefficient(s)	2393.96	
Std Err of Coef.	173.51		Std Err of Coef.	126.41	

Table 13. Regressions to compute growth in gross domestic product in selected Asian countries

Page 2 of 2

Current Currency			Constant Currency		
South Korea (won)					
Constant		–346.69	Constant		–147.176
Std Err of Y Est		0.137	Std Err of Y Est		0.048
R Squared		0.97	R Squared		0.98
No. of Observations		15	No. of Observations		15
Degrees of Freedom		13	Degrees of Freedom		13
Growth Rate	19.8%		Growth Rate	8.3%	
X Coefficient(s)	0.180		X Coefficient(s)	0.08	
Std Err of Coef.	0.008		Std Err of Coef.	0.002	
Taiwan (New Taiwanese dollars)					
Constant		–241	Constant		–159
Std Err of Y Est		0.098	Std Err of Y Est		0.076
R Squared		0.97	R Squared		0.97
No. of Observations		16	No. of Observations		16
Degrees of Freedom		14	Degrees of Freedom		14
Growth Rate	13.8%		Growth Rate	9.1%	
X Coefficient(s)	0.13		X Coefficient(s)	0.09	
Std Err of Coef.	0.005		Std Err of Coef.	0.004	
Total Asian ($PPPs (1))					
			Constant		–79.651
			Std Err of Y Est		0.033
			R Squared		0.97
			No. of Observations		13
			Degrees of Freedom		11
			Growth Rate	4.9%	
			X Coefficient(s)	0.047	
			Std Err of Coef.	0.002	
United States (dollars)					
			Constant		–42
			Std Err of Y Est		0.028
			R Squared		0.962
			No. of Observations		16
			Degrees of Freedom		14
			Growth Rate	2.9%	
			X Coefficient(s)	0.028	
			Std Err of Coef.	0.001	

(1) $PPPs = purchasing power parity dollars

Appendixes

Table A-1. Growth in enrollment in higher education in selected Asian countries: 1975–90

Page 1 of 1

Year	China	India	Japan	Singapore	South Korea	Taiwan
1975 . . .	500,993	2,300,000	2,248,903	18,501	318,683	289,435
1976 . . .	564,715	2,431,563	2,299,344	20,594	345,679	299,414
1977 . . .	625,000	2,564,972	2,336,337	20,734	404,404	308,583
1978 . . .	856,000	2,618,228	2,373,924	20,377	473,106	317,188
1979 . . .	1,020,000	2,648,579	2,412,117	20,464	553,478	329,603
1980 . . .	1,144,000	2,752,437	2,412,117	22,633	647,505	342,528
1981 . . .	1,279,000	2,952,066	2,402,725	24,393	829,915	358,437
1982 . . .	1,154,000	3,133,093	2,391,915	26,960	1,028,933	375,696
1983 . . .	1,237,394	3,322,939	2,409,983	31,145	1,204,053	395,153
1984 . . .	1,443,605	3,404,096	2,403,371	35,943	1,345,114	412,381
1985 . . .	1,778,608	3,605,029	2,347,463	39,913	1,455,759	428,576
1986 . . .	1,976,950	3,754,409	2,409,687	42,317	1,514,784	442,648
1987 . . .	2,064,910	3,910,828	2,372,124	44,976	1,548,772	464,664
1988 . . .	2,118,320	4,074,676	2,445,052	46,990	1,573,369	496,530
1989 . . .	2,173,112	4,246,878	2,528,811	50,756	1,583,076	505,152
1990 . . .	2,651,396	4,425,247	2,654,379	50,756	1,583,076	526,462

NOTE: Data include all levels of higher education except for India, which excludes junior colleges and Indian Institutes of Technology.

SOURCES: India: Government of India, University Grants Commission, 1990, *Annual Report for the Year 1988–89* (New Delhi); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei); other countries: UNESCO, 1975–92, *Statistical Yearbook*, annual series

Table A-2. Ratio of university enrollments to the 20- to 24-year-old population in selected Asian countries: 1975–90

Page 1 of 1

Year	China	India	Japan	Singapore	South Korea	Taiwan
1975	0.01	0.04	0.24	0.07	0.10	0.17
1976	.01	.04	.26	.08	.11	.17
1977	.01	.04	.27	.08	.12	.17
1978	.01	.04	.28	.07	.13	.17
1979	.01	.04	.30	.07	.14	.17
1980	.01	.04	.31	.08	.16	.18
1981	.01	.04	.30	.08	.20	.19
1982	.01	.05	.30	.09	.25	.19
1983	.01	.05	.30	.10	.29	.20
1984	.01	.05	.30	.12	.32	.21
1985	.02	.05	.29	.13	.34	.22
1986	.02	.05	.29	.14	.36	.23
1987	.02	.05	.28	.16	.36	.24
1988	.02	.05	.28	.17	.37	.26
1989	.02	.05	.29	.19	.37	.27
1990	.02	.05	.30	.19	.37	.28

SOURCE: Computed, tables A-1 and A-15

Table A-3. Bachelor's degrees in science and engineering in selected Asian countries and the United States: 1975–90

Page 1 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total	United States
				Natural science				
1975 . . .	NA	99,348	18,984	466	5,657	3,700	128,155	117,001
1976 . . .	NA	102,661	19,977	490	5,791	4,111	133,030	120,609
1977 . . .	NA	106,156	20,689	335	6,175	3,946	137,301	121,819
1978 . . .	NA	109,854	21,625	347	6,699	4,126	142,651	120,238
1979 . . .	NA	106,004	23,871	528	7,279	4,151	141,833	119,118
1980 . . .	NA	108,054	22,736	573	7,922	4,334	143,619	117,964
1981 . . .	NA	110,151	23,358	460	9,006	4,341	147,315	118,667
1982 . . .	76,842	112,295	22,771	577	10,448	4,491	227,424	121,552
1983 . . .	40,301	114,488	22,381	663	11,394	4,674	193,901	123,973
1984 . . .	35,481	116,731	23,423	726	12,486	4,661	193,508	129,149
1985 . . .	36,493	128,236	23,626	854	15,068	4,987	209,264	136,047
1986 . . .	39,773	129,964	23,805	945	15,235	5,251	214,973	136,910
1987 . . .	42,082	137,717	24,655	1,012	16,626	5,472	227,564	132,923
1988 . . .	45,569	137,827	23,972	982	21,547	5,990	235,887	123,115
1989 . . .	49,485	141,684	23,547	1,166	22,550	6,182	244,614	116,343
1990 . . .	49,834	146,774	25,153	1,278	23,195	6,533	252,767	105,021
				Engineering				
1975 . . .	NA	14,073	66,512	236	7,155	5,000	92,976	39,824
1976 . . .	NA	15,057	68,126	241	7,272	5,142	95,838	38,790
1977 . . .	NA	16,110	70,431	290	7,858	5,258	99,947	41,357
1978 . . .	NA	17,237	72,466	240	8,919	5,559	104,421	47,251
1979 . . .	NA	17,236	75,409	272	10,124	6,315	109,356	53,469
1980 . . .	NA	18,100	74,737	288	11,492	6,463	111,080	58,810
1981 . . .	NA	19,007	76,370	323	13,044	7,299	116,043	63,717
1982 . . .	145,263	19,959	74,774	349	14,806	7,309	262,461	67,460
1983 . . .	89,726	20,960	70,824	585	20,636	7,320	210,050	72,670
1984 . . .	77,388	22,010	71,640	585	22,190	7,330	201,143	76,153
1985 . . .	63,132	21,088	72,560	769	23,539	7,703	188,791	77,572
1986 . . .	72,703	24,096	74,516	924	27,612	7,730	207,581	76,820
1987 . . .	92,994	27,057	77,077	907	27,600	7,508	233,143	74,425
1988 . . .	104,271	27,000	77,503	1,001	26,891	7,994	244,660	70,154
1989 . . .	116,915	28,000	77,009	1,105	28,141	8,007	259,177	66,947
1990 . . .	112,814	29,000	81,355	1,220	28,071	8,950	261,410	64,705

See explanatory information and SOURCES at end of table.

Table A-3. Bachelor's degrees in science and engineering in selected Asian countries and the United States: 1975–90

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total	United States
Natural science and engineering								
1975	NA	113,421	85,496	702	12,812	8,700	221,131	156,825
1976	NA	117,718	88,103	731	13,063	9,253	228,868	159,399
1977	NA	122,266	91,120	625	14,033	9,204	237,248	163,176
1978	NA	127,091	94,091	587	15,619	9,685	247,073	167,489
1979	NA	123,240	99,280	800	17,403	10,466	251,189	172,587
1980	NA	126,154	97,473	861	19,413	10,797	254,698	176,774
1981	NA	129,157	99,728	783	22,050	11,640	263,358	182,384
1982	222,105	132,254	97,545	926	25,254	11,801	489,885	189,012
1983	130,027	135,447	93,205	1,248	32,030	11,994	403,951	196,643
1984	112,869	138,741	95,063	1,311	34,676	11,991	394,651	205,302
1985	99,625	149,324	96,186	1,623	38,607	12,690	398,055	213,619
1986	112,476	154,060	98,321	1,869	42,847	12,981	422,554	213,730
1987	135,076	164,774	101,732	1,919	44,226	12,980	460,707	207,348
1988	149,839	164,827	101,475	1,983	48,438	13,984	480,546	193,269
1989	166,400	169,684	100,556	2,271	50,691	14,189	503,791	183,290
1990	162,648	175,774	106,508	2,498	51,266	15,483	514,177	169,726
Science and engineering (includes social sciences)								
1975	NA	113,421	220,141	702	12,812	11,300	358,376	319,972
1976	NA	117,718	227,361	731	14,486	12,015	372,311	316,804
1977	NA	122,266	234,536	625	15,412	12,091	384,930	311,709
1978	NA	127,091	245,610	587	17,070	12,568	402,926	311,507
1979	NA	123,240	257,303	800	18,931	13,421	413,695	311,490
1980	NA	126,154	255,867	861	21,022	13,703	417,607	312,406
1981	NA	129,157	260,248	783	23,743	14,529	428,461	314,991
1982	222,105	132,254	256,995	926	27,037	14,854	654,171	322,577
1983	130,027	135,447	245,201	1,248	36,327	15,028	563,278	325,294
1984	112,869	138,741	246,689	1,401	37,973	15,125	552,798	331,380
1985	99,625	149,324	247,258	1,709	45,079	15,955	558,950	338,652
1986	112,476	154,060	249,377	1,960	50,517	16,090	584,480	341,288
1987	150,761	164,774	252,688	2,025	53,093	16,277	639,618	339,283
1988	169,145	164,827	252,294	2,089	58,057	17,311	663,723	329,986
1989	190,162	169,684	247,643	2,373	58,789	17,348	685,999	330,027
1990	187,953	175,774	263,985	2,615	61,477	18,657	710,461	329,094

See explanatory information and SOURCES at end of table.

Table A-3. Bachelor's degrees in science and engineering in selected Asian countries and the United States: 1975–90

Page 3 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total	United States
				Total, all fields				
1975	NA	NA	313,072	2,380	NA	NA	315,452	931,663
1976	NA	629,336	326,167	2,388	34,725	29,053	1,021,669	934,443
1977	NA	651,999	339,819	2,357	37,374	29,685	1,061,234	928,228
1978	NA	675,478	356,981	2,422	41,447	30,740	1,107,068	930,197
1979	NA	620,247	374,887	2,763	45,964	32,383	1,076,243	931,340
1980	NA	599,795	378,666	2,645	50,973	34,223	1,066,302	940,251
1981	NA	522,963	386,057	2,187	56,528	32,214	999,949	946,877
1982	365,787	560,893	382,466	2,395	62,688	33,341	1,407,570	964,043
1983	252,571	595,288	369,069	2,905	77,272	34,507	1,331,612	980,679
1984	204,248	628,453	372,247	3,725	90,888	35,714	1,335,275	986,345
1985	201,885	646,778	373,302	4,286	118,584	36,885	1,381,720	990,880
1986	227,764	678,470	376,260	4,818	137,848	38,567	1,463,727	1,000,352
1987	252,122	699,555	382,655	5,119	149,582	38,929	1,527,962	1,000,532
1988	279,084	724,739	382,828	5,227	161,983	40,205	1,594,066	1,006,033
1989	307,865	740,000	376,688	5,850	166,845	40,856	1,638,104	1,030,171
1990	308,930	750,000	400,103	6,000	165,916	42,952	1,673,901	1,062,151

NOTES: Natural science includes physical; biological; earth, atmospheric, and oceanographic; agricultural; and math and computer sciences. National data were reconfigured to include only fields of study corresponding to classification of instructional programs used in surveys of higher education in the United States. India data are estimated for 1988–90; Singapore data are estimated for 1990. China begins to report social science in 1987. India does not report social science. Singapore begins to report social science in 1984.

KEY: NA = Not available

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; China: Government of the People's Republic of China, State Education Commission, Department of Planning and Construction, 1990, *Educational Statistics Yearbook of China* (Beijing); India: Government of India, University Grants Commission, 1990, *Annual Report for the Year 1988–89* (New Delhi), and Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); Singapore: University of Singapore, 1974–89, *Annual Report*, annual series; South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei); United States: National Science Foundation, 1992, *Science and Engineering Degrees: 1966–90, A Source Book*, NSF 92-326 (Washington, DC)

Table A-4. Bachelor's degrees in science and engineering earned by women in selected Asian countries and the United States: 1975–90

Page 1 of 3

Year	Japan	South Korea	Taiwan	Total	United States
			Natural science		
1975	2,395	NA	NA	2,395	33,305
1976	2,649	865	776	4,290	35,606
1977	2,833	870	758	4,461	37,648
1978	2,962	973	907	4,842	39,051
1979	3,108	1,094	970	5,172	40,256
1980	3,338	1,236	1,041	5,615	41,494
1981	3,599	1,404	1,084	6,087	43,190
1982	3,462	1,601	1,188	6,251	45,438
1983	3,619	2,041	1,252	6,912	47,511
1984	3,892	2,951	1,290	8,133	49,931
1985	4,226	4,483	1,317	10,026	53,313
1986	4,532	4,444	1,647	10,623	53,614
1987	4,720	4,885	1,682	11,287	51,971
1988	4,414	5,585	1,634	11,633	48,795
1989	4,387	6,400	1,606	12,393	45,648
1990	4,932	7,242	1,810	13,984	42,680
			Engineering		
1975	565	NA	NA	565	860
1976	556	96	224	876	1,443
1977	627	108	246	981	2,086
1978	723	113	256	1,092	3,497
1979	764	118	411	1,293	4,919
1980	863	123	459	1,445	6,014
1981	1,009	128	451	1,588	7,117
1982	1,143	136	489	1,768	8,337
1983	1,155	161	558	1,874	9,719
1984	1,506	470	636	2,612	10,833
1985	1,706	312	713	2,731	11,316
1986	2,027	315	539	2,881	11,203
1987	2,359	598	657	3,614	11,473
1988	2,431	842	723	3,996	10,840
1989	2,531	1,098	715	4,344	10,244
1990	2,650	1,308	840	4,798	9,973

See explanatory information and SOURCES at end of table.

Table A-4. Bachelor's degrees in science and engineering earned by women in selected Asian countries and the United States: 1975–90

Page 2 of 3

Year	Japan	South Korea	Taiwan	Total	United States
			Natural science and engineering		
1975	2,960	NA	NA	2,960	34,165
1976	3,205	961	1,000	5,166	37,049
1977	3,460	978	1,004	5,442	39,734
1978	3,685	1,086	1,163	5,934	42,548
1979	3,872	1,212	1,381	6,465	45,175
1980	4,201	1,359	1,500	7,060	47,508
1981	4,608	1,532	1,535	7,675	50,307
1982	4,605	1,737	1,677	8,019	53,775
1983	4,774	2,202	1,810	8,786	57,230
1984	5,398	3,421	1,926	10,745	60,764
1985	5,932	4,795	2,030	12,757	64,629
1986	6,559	4,759	2,186	13,504	64,817
1987	7,079	5,483	2,339	14,901	63,444
1988	6,845	6,427	2,357	15,629	59,635
1989	6,918	7,498	2,321	16,737	55,892
1990	7,582	8,550	2,650	18,782	52,653
			Science and engineering (includes social sciences)		
1975	12,226	NA	NA	12,226	104,256
1976	13,841	1,226	2,175	17,242	106,000
1977	15,373	1,221	2,291	18,885	107,394
1978	16,891	1,340	2,390	20,621	110,276
1979	18,112	1,477	2,709	22,298	112,715
1980	18,464	1,636	2,951	23,051	116,131
1981	19,406	1,822	3,000	24,228	118,693
1982	18,535	2,040	3,157	23,732	124,080
1983	18,282	2,654	3,418	24,354	125,489
1984	18,996	3,973	3,605	26,574	127,283
1985	19,558	6,180	3,790	29,528	130,892
1986	20,325	6,684	3,886	30,895	132,532
1987	22,018	8,026	4,151	34,195	133,879
1988	23,052	9,092	4,182	36,326	133,220
1989	23,105	9,434	4,249	36,788	135,741
1990	26,101	11,182	4,657	41,940	140,012

See explanatory information and SOURCES at end of table.

Table A-4. Bachelor's degrees in science and engineering earned by women in selected Asian countries and the United States: 1975–90

Page 3 of 3

Year	Japan	South Korea	Taiwan	Total	United States
			Total, all fields		
1975	67,540	NA	NA	67,540	423,239
1976	74,146	11,198	10,309	95,653	425,894
1977	80,539	12,160	11,016	103,715	429,107
1978	86,131	13,187	11,135	110,453	439,135
1979	91,660	14,301	12,070	118,031	449,946
1980	93,698	15,509	12,780	121,987	462,501
1981	95,543	16,819	12,948	125,310	472,541
1982	92,580	18,240	13,333	124,153	486,500
1983	90,097	22,703	15,299	128,099	497,284
1984	91,452	27,738	15,602	134,792	499,595
1985	92,367	42,771	16,431	151,569	504,217
1986	93,679	50,607	16,987	161,273	510,061
1987	99,040	57,840	17,983	174,863	518,529
1988	100,271	58,704	17,831	176,806	524,797
1989	100,640	59,836	18,459	178,935	542,605
1990	109,750	61,289	19,396	190,435	566,284

NOTES: Natural science includes physical; biological; earth, atmospheric, and oceanographic; agricultural; and math and computer sciences. National data were reconfigured to include only fields of study corresponding to classification of instructional programs used in surveys of higher education in the United States. China and India do not report degree data by gender; Singapore data are incomplete.

KEY: NA = Not available

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei); United States: National Science Foundation, 1992, *Science and Engineering Degrees: 1966–90, A Source Book*, NSF 92-326 (Washington, DC)

Table A-5. Advanced degrees (master's and doctoral) in science and engineering in selected Asian countries and the United States: 1975–90

Page 1 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total	United States
				Natural science				
1975	NA	20,625	3,047	18	NA	NA	23,690	31,335
1976	NA	21,130	3,102	11	414	448	25,105	30,640
1977	NA	21,700	3,500	9	487	460	26,156	31,188
1978	NA	22,345	3,585	8	727	529	27,194	31,268
1979	NA	22,564	3,555	7	822	490	27,438	31,080
1980	69	23,315	3,553	6	967	527	28,437	30,852
1981	2,452	24,094	3,590	7	1,186	654	31,983	30,774
1982	739	24,901	3,543	2	1,109	691	30,985	32,151
1983	858	25,738	3,757	8	1,569	692	32,622	32,350
1984	482	26,607	4,578	11	1,718	697	34,093	33,166
1985	4,522	27,660	4,903	11	2,472	762	40,330	33,981
1986	3,324	28,818	4,963	13	2,283	945	40,346	35,336
1987	6,234	30,060	5,200	31	2,484	1,019	45,028	36,120
1988	6,060	30,458	5,529	46	2,726	1,177	45,996	37,241
1989	6,943	30,849	6,110	46	2,659	1,354	47,961	37,607
1990	6,760	32,800	11,639	50	3,056	1,604	55,909	37,621
				Engineering				
1975	NA	1,364	6,721	5	NA	NA	8,090	18,445
1976	NA	1,563	6,440	42	319	265	8,629	19,008
1977	NA	1,794	7,705	45	334	314	10,192	19,537
1978	NA	2,062	8,355	49	464	403	11,333	19,440
1979	NA	2,086	8,358	53	645	395	11,537	18,687
1980	205	2,091	7,879	57	896	485	11,613	19,325
1981	3,515	2,095	7,733	64	1,246	528	15,181	19,901
1982	793	2,100	8,061	72	1,731	634	13,391	21,240
1983	1,348	2,105	8,367	148	2,012	761	14,741	22,502
1984	1,011	2,110	8,952	132	2,191	914	15,310	23,265
1985	4,971	1,935	9,251	135	2,504	1,151	19,947	24,372
1986	5,026	2,675	10,303	155	2,844	1,362	22,365	24,690
1987	11,051	3,162	11,137	157	3,037	1,551	30,095	25,993
1988	12,850	2,829	11,956	151	3,852	1,868	33,506	27,081
1989	14,943	2,933	12,954	132	4,020	2,071	37,053	28,464
1990	14,027	3,050	24,910	150	4,014	2,407	48,558	28,887

See explanatory information and SOURCES at end of table.

Table A-5. Advanced degrees (master's and doctoral) in science and engineering in selected Asian countries and the United States: 1975–90

Page 2 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total	United States
				Natural science and engineering				
1975	NA	21,989	9,768	23	NA	NA	31,780	49,780
1976	NA	22,693	9,542	53	733	713	33,734	49,648
1977	NA	23,494	11,205	55	821	774	36,349	50,725
1978	NA	24,407	11,940	57	1,191	932	38,527	50,708
1979	NA	24,650	11,913	60	1,467	885	38,975	49,767
1980	274	25,406	11,432	63	1,863	1,012	40,050	50,177
1981	5,967	26,189	11,323	71	2,432	1,182	47,164	50,675
1982	1,532	27,001	11,604	74	2,840	1,325	44,376	53,391
1983	2,206	27,844	12,124	156	3,581	1,454	47,364	54,852
1984	1,493	28,717	13,530	143	3,909	1,611	49,403	56,431
1985	9,493	29,595	14,15[illegible]	146	4,976	1,913	60,227	58,353
1986	8,350	31,493	[illegible],266	168	5,127	2,307	62,711	60,026
1987	17,285	33,222	16,337	188	5,521	2,570	75,123	62,113
1988	18,910	33,287	17,485	197	6,578	3,045	79,502	64,322
1989	21,886	33,782	19,064	178	6,679	3,425	85,014	66,071
1990	20,787	35,850	36,549	200	7,070	4,011	104,467	66,508
				Science and engineering (includes social science)				
1975	NA	21,989	11,940	23	NA	NA	33,952	82,815
1976	NA	22,693	11,706	53	894	920	36,266	84,046
1977	NA	23,494	13,250	55	939	1,013	38,751	86,712
1978	NA	24,407	14,062	57	1,335	1,160	41,022	86,355
1979	NA	24,650	14,005	60	1,645	1,079	41,438	83,504
1980	274	25,406	13,535	63	2,081	1,241	42,600	83,221
1981	5,967	26,189	13,448	71	2,699	1,761	50,135	83,994
1982	1,532	27,001	13,571	74	3,089	1,789	47,056	86,291
1983	2,206	27,844	14,059	158	3,983	1,826	50,075	87,602
1984	1,493	28,717	15,533	147	4,436	1,909	52,235	87,983

See explanatory information and SOURCES at end of table.

Table A-5. Advanced degrees (master's and doctoral) in science and engineering in selected Asian countries and the United States: 1975–90

Page 3 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total	United States
	Science and engineering (includes social science)							
1985	9,493	29,595	16,333	157	5,801	2,283	63,662	90,117
1986	8,350	31,493	17,441	175	5,975	2,679	66,113	91,901
1987	18,852	33,222	18,619	194	6,344	3,000	80,231	93,618
1988	20,661	33,287	19,906	204	7,376	3,497	84,931	95,606
1989	23,843	33,782	21,624	184	7,495	3,711	90,639	99,059
1990	22,579	35,850	41,530	206	7,986	4,288	112,439	100,639

NOTES: Natural science includes physical; biological; earth, atmospheric, and oceanographic; agricultural; and math and computer sciences. National data were reconfigured to include only fields of study corresponding to classification of instructional programs used in surveys of higher education in the United States. India data are estimated for 1988–90; Singapore data are estimated for 1990.

KEY: NA = Not available

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; China: Government of the People's Republic of China, State Education Commission, Department of Planning and Construction, 1990, *Educational Statistics Yearbook of China* (Beijing); India: Government of India, University Grants Commission, 1990, *Annual Report for the Year 1988–89* (New Delhi), and Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); Singapore: University of Singapore, 1974–89, *Annual Report*, annual series; South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei); United States: National Science Foundation, 1992, *Science and Engineering Degrees: 1966–90, A Source Book*, NSF 92-326 (Washington, DC)

Table A-6. Advanced degrees (master's and doctoral) in science and engineering earned by women in selected Asian countries and the United States: 1975–90

Page 1 of 3

Year	Japan	South Korea	Taiwan	Total	United States
			Natural science		
1975	182	NA	NA	182	6,140
1976	181	41	68	290	6,258
1977	222	46	62	330	6,766
1978	210	63	74	347	7,077
1979	238	87	76	401	7,379
1980	274	120	83	477	7,555
1981	273	165	91	529	7,699
1982	238	227	110	575	8,590
1983	293	252	126	671	9,037
1984	474	269	149	892	9,488
1985	515	535	182	1,232	9,853
1986	538	609	209	1,356	10,531
1987	613	786	208	1,607	10,907
1988	690	387	259	1,336	10,979
1989	843	467	327	1,637	11,630
1990	1,533	563	358	2,454	11,946
			Engineering		
1975	24	NA	NA	24	424
1976	36	5	4	45	623
1977	38	3	6	47	772
1978	39	5	7	51	896
1979	62	7	7	76	999
1980	64	11	11	86	1,213
1981	80	17	18	115	1,428
1982	83	26	20	129	1,699
1983	86	27	22	135	1,879
1984	119	20	24	163	2,251
1985	129	41	32	202	2,442
1986	180	70	50	300	2,625
1987	198	43	58	299	3,012
1988	263	63	58	384	3,094
1989	318	80	94	492	3,457
1990	581	123	116	820	3,683

See explanatory information and SOURCES at end of table.

Table A-6. Advanced degrees (master's and doctoral) in science and engineering earned by women in selected Asian countries and the United States: 1975–90

Page 2 of 3

Year	Japan	South Korea	Taiwan	Total	United States
Natural science and engineering					
1975	206	NA	NA	206	6,564
1976	217	46	72	335	6,881
1977	260	49	68	377	7,538
1978	249	68	81	398	7,973
1979	300	94	83	477	8,378
1980	338	131	94	563	8,768
1981	353	182	109	644	9,127
1982	321	253	130	704	10,289
1983	379	279	148	806	10,916
1984	593	289	173	1,055	11,739
1985	644	576	214	1,434	12,295
1986	718	679	259	1,656	13,156
1987	811	829	266	1,906	13,919
1988	953	450	317	1,720	14,073
1989	1,161	547	421	2,129	15,087
1990	2,114	686	474	3,274	15,629
Science and engineering (includes social sciences)					
1975	342	NA	NA	342	16,717
1976	350	65	97	512	18,112
1977	389	62	107	558	19,731
1978	424	82	126	632	20,684
1979	481	109	117	707	21,356
1980	547	147	141	835	22,046
1981	560	199	217	976	23,062
1982	536	271	231	1,038	24,361
1983	621	318	243	1,182	25,713
1984	834	318	263	1,415	26,323

See explanatory information and SOURCES at end of table.

Table A-6. Advanced degrees (master's and doctoral) in science and engineering earned by women in selected Asian countries and the United States: 1975–90

Page 3 of 3

Year	Japan	South Korea	Taiwan	Total	United States
	Science and engineering (includes social sciences)				
1985	955	685	307	1,947	27,221
1986	1,055	799	380	2,234	28,386
1987	1,179	986	417	2,582	29,154
1988	1,373	567	471	2,411	29,438
1989	1,642	657	517	2,816	31,686
1990	3,015	845	588	4,448	32,902

NOTES: Natural science includes physical; biological; earth, atmospheric, and oceanographic; agricultural; and math and computer sciences. National data were reconfigured to include only fields of study corresponding to classification of instructional programs used in surveys of higher education in the United States. China and India do not report degree data by gender; Singapore data are incomplete.

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei); United States: National Science Foundation, 1992, *Science and Engineering Degrees: 1966–90, A Source Book*, NSF 92-326 (Washington, DC)

Table A-7. Doctoral degrees in science and engineering in selected Asian countries and the United States: 1975–90

Page 1 of 3

Year	China	India	Japan	South Korea	Taiwan	Total	United States
				Natural science			
1975	NA	1,773	669	NA	NA	2,442	9,250
1976	NA	1,979	638	77	6	2,700	8,866
1977	NA	2,209	768	62	8	3,047	8,640
1978	NA	2,466	743	73	12	3,294	8,560
1979	NA	2,741	753	86	12	3,592	8,796
1980	NA	2,903	785	104	12	3,803	8,826
1981	NA	3,074	861	127	24	4,085	8,956
1982	NA	3,255	807	157	16	4,235	9,135
1983	NA	3,448	782	143	29	4,402	9,182
1984	NA	3,652	743	201	31	4,627	9,329
1985	NA	3,620	833	301	34	4,788	9,433
1986	NA	3,530	772	306	63	4,671	9,613
1987	NA	3,870	828	387	77	5,162	9,843
1988	NA	3,958	851	435	77	5,321	10,431
1989	646	4,049	1,007	472	96	6,270	10,652
1990	772	4,600	937	399	104	6,812	11,368
				Engineering			
1975	NA	136	576	NA	NA	712	3,011
1976	NA	135	558	20	8	721	2,838
1977	NA	135	672	14	3	824	2,648
1978	NA	134	591	20	3	748	2,425
1979	NA	176	665	29	8	878	2,494
1980	NA	179	665	42	10	896	2,479
1981	NA	182	697	60	15	955	2,528
1982	NA	185	634	87	15	921	2,646
1983	NA	189	591	97	14	891	2,781
1984	NA	192	575	120	31	918	2,913
1985	NA	194	559	197	59	1,009	3,166
1986	NA	215	599	273	83	1,170	3,376
1987	NA	225	642	270	98	1,235	3,711
1988	NA	229	736	346	98	1,409	4,189
1989	971	233	930	415	120	2,669	4,536
1990	1,054	250	948	439	165	2,856	4,892

See explanatory information and SOURCES at end of table.

Table A-7. Doctoral degrees in science and engineering in selected Asian countries and the United States: 1975–90

Page 2 of 3

Year	China	India	Japan	South Korea	Taiwan	Total	United States
Natural science and engineering							
1975	NA	1,909	1,245	NA	NA	3,154	12,261
1976	NA	2,114	1,196	97	14	3,421	11,704
1977	NA	2,344	1,440	76	11	3,871	11,288
1978	NA	2,600	1,334	93	15	4,042	10,985
1979	NA	2,917	1,418	115	20	4,470	11,290
1980	NA	3,082	1,450	146	22	4,699	11,305
1981	NA	3,256	1,558	187	39	5,040	11,484
1982	NA	3,441	1,441	244	31	5,157	11,781
1983	NA	3,637	1,373	240	43	5,293	11,963
1984	NA	3,844	1,318	321	62	5,545	12,242
1985	NA	3,814	1,392	498	93	5,797	12,599
1986	NA	3,745	1,371	579	146	5,841	12,989
1987	NA	4,095	1,470	657	175	6,397	13,554
1988	NA	4,187	1,587	781	175	6,730	14,620
1989	1,617	4,282	1,937	887	216	8,939	15,188
1990	1,826	4,850	1,885	838	269	9,668	16,260
Science and engineering (includes social sciences)							
1975	NA	1,909	1,689	NA	NA	3,598	18,701
1976	NA	2,114	1,695	128	21	3,958	18,268
1977	NA	2,344	1,891	99	24	4,358	17,723
1978	NA	2,600	1,788	116	17	4,521	17,383
1979	NA	2,917	1,864	139	26	4,946	17,589
1980	NA	3,082	1,914	170	30	5,195	17,524
1981	NA	3,256	2,081	212	49	5,598	17,996
1982	NA	3,441	1,961	269	44	5,715	18,017
1983	NA	3,637	1,832	281	58	5,808	18,393
1984	NA	3,844	1,785	360	85	6,074	18,514
1985	NA	3,814	1,915	548	109	6,386	18,710
1986	NA	3,745	1,861	631	172	6,409	19,252
1987	NA	4,095	1,959	759	197	7,010	19,703
1988	NA	4,187	2,123	871	197	7,378	20,735
1989	1,679	4,282	2,438	984	257	9,640	21,516
1990	1,940	4,850	2,367	945	312	10,414	22,853

NOTES: Natural science includes physical; biological; earth, atmospheric, and oceanographic; agricultural; and math and computer sciences. National data were reconfigured to include only fields of

Table A-7. Doctoral degrees in science and engineering in selected Asian countries and the United States: 1975–90

Page 3 of 3

study corresponding to classification of instructional programs used in surveys of higher education in the United States. China and India do not include social science degrees in reporting science and engineering degrees.

KEY: NA = Not available

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; China: Government of the People's Republic of China, State Education Commission, Department of Planning and Construction, 1990, *Educational Statistics Yearbook of China* (Beijing); India: Government of India, University Grants Commission, 1990, *Annual Report for the Year 1988–89* (New Delhi), and Government of India, Department of Science and Technology, 1990, *Research and Development Statistics, 1988–89* (New Delhi); Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei); United States: National Science Foundation, 1992, *Science and Engineering Degrees: 1966–90, A Source Book*, NSF 92-326 (Washington, DC)

Table A-8. Doctoral degrees in science and engineering earned by women in selected Asian countries and the United States: 1975–90

Page 1 of 3

Year	Japan	South Korea	Taiwan	Total	United States
Natural science					
1975	30	0	0	30	1,252
1976	30	4	0	34	1,272
1977	34	2	0	36	1,273
1978	35	0	1	36	1,397
1979	36	0	1	37	1,527
1980	40	0	1	41	1,652
1981	40	0	1	41	1,724
1982	37	15	2	54	1,868
1983	42	19	2	63	1,983
1984	57	21	3	81	2,005
1985	51	24	1	76	2,123
1986	47	37	10	94	2,226
1987	73	71	9	153	2,362
1988	65	31	9	105	2,570
1989	88	39	11	138	2,799
1990	97	36	16	149	2,919
Engineering					
1975	2	0	0	2	52
1976	4	0	0	4	55
1977	3	0	0	3	74
1978	3	0	1	4	53
1979	6	0	0	6	62
1980	8	0	0	8	90
1981	6	0	0	6	99
1982	7	0	0	7	124
1983	14	0	0	14	124
1984	10	0	0	10	151
1985	12	7	4	23	198
1986	20	9	0	29	225
1987	16	2	3	21	242
1988	12	11	3	26	286
1989	35	5	4	44	375
1990	41	8	1	50	414

See explanatory information and SOURCES at end of table.

Table A-8. Doctoral degrees in science and engineering earned by women in selected Asian countries and the United States: 1975–90

Page 2 of 3

Year	Japan	South Korea	Taiwan	Total	United States
Natural science and engineering					
1975	32	0	0	32	1,304
1976	34	4	0	38	1,327
1977	37	2	0	39	1,347
1978	38	0	2	40	1,450
1979	42	0	1	43	1,589
1980	48	0	1	49	1,742
1981	46	0	1	47	1,823
1982	44	15	2	61	1,992
1983	56	19	2	77	2,107
1984	67	21	3	91	2,156
1985	63	31	5	99	2,321
1986	67	46	10	123	2,451
1987	89	73	12	174	2,604
1988	77	42	13	132	2,856
1989	123	44	15	182	3,174
1990	138	44	17	199	3,333
Science and engineering (includes social sciences)					
1975	50	0	0	50	2,929
1976	54	4	0	58	3,097
1977	57	2	1	60	3,233
1978	59	0	3	62	3,454
1979	69	0	1	70	3,744
1980	84	0	2	86	3,961
1981	86	0	2	88	4,201
1982	73	15	3	91	4,350
1983	83	20	4	107	4,715
1984	105	21	4	130	4,792
1985	108	34	6	148	4,891
1986	108	53	11	172	5,166
1987	146	78	17	241	5,310
1988	136	46	16	198	5,657
1989	183	53	17	253	6,106
1990	200	52	21	273	6,344

NOTES: Natural science includes physical; biological; earth, atmospheric, and oceanographic; agricultural; and math and computer sciences. National data were reconfigured to include only fields of study corresponding to classification of instructional programs used in surveys of higher education in the United States. China and India do not report degree data by gender; Singapore data are incomplete.

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; China: Government of the People's Republic of China, State Education Commission, Department of Planning and Construction, 1990, *Educational Statistics Yearbook of China* (Beijing); India: Government of India, University Grants Commission, 1990, *Annual Report for the Year 1988–89* (New Delhi), and Government of India, Department of Science and Technology, 1990, *Research and Development Statistics, 1988–89* (New Delhi); Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei); United States: National Science Foundation, 1992, *Science and Engineering Degrees: 1966–90, A Source Book*, NSF 92-326 (Washington, DC)

Table A-9. Bachelor's degrees in science and engineering in selected Asian countries, by field: 1975–90

Page 1 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total
			Social and behavioral science				
1975	NA	NA	134,645	NA	NA	2,600	137,245
1976	NA	NA	139,258	NA	1,423	2,762	143,443
1977	NA	NA	143,416	NA	1,379	2,887	147,682
1978	NA	NA	151,519	NA	1,452	2,883	155,854
1979	NA	NA	158,023	NA	1,528	2,955	162,506
1980	NA	NA	158,394	NA	1,609	2,906	162,909
1981	NA	NA	160,520	NA	1,694	2,889	165,103
1982	NA	NA	159,450	NA	1,783	3,053	164,286
1983	NA	NA	151,996	NA	4,297	3,034	159,327
1984	NA	NA	151,626	90	3,297	3,134	158,147
1985	NA	NA	151,072	86	6,472	3,265	160,895
1986	NA	NA	151,056	91	7,670	3,109	161,926
1987	15,685	NA	150,956	106	8,867	3,297	178,911
1988	19,306	NA	150,819	106	9,619	3,327	183,177
1989	23,762	NA	147,087	102	8,098	3,159	182,208
1990	25,305	NA	157,477	117	10,211	3,174	196,284
			Natural science				
1975	NA	95,382	7,014	466	3,111	1,700	107,673
1976	NA	98,038	7,483	490	2,713	1,877	110,601
1977	NA	100,768	7,479	335	2,889	1,793	113,264
1978	NA	103,574	7,985	347	3,165	1,935	117,006
1979	NA	99,724	8,248	528	3,468	1,880	113,848
1980	NA	101,455	8,636	573	3,800	1,935	116,399
1981	NA	103,217	8,651	460	4,164	1,866	118,357
1982	29,127	105,008	8,710	577	4,562	1,945	149,929
1983	15,195	106,831	8,575	663	5,202	1,980	138,446
1984	15,856	108,686	9,054	726	6,241	1,992	142,555
1985	13,106	119,979	9,166	854	8,112	2,091	153,308
1986	14,175	122,550	9,435	945	6,913	2,148	156,166
1987	14,717	129,907	9,817	1,012	7,082	2,253	164,788
1988	15,765	130,000	9,895	982	7,673	2,380	166,695
1989	16,888	134,000	9,900	1,166	8,249	2,428	172,631
1990	16,570	139,000	9,866	1,278	8,514	2,481	177,709

See explanatory information and SOURCES at end of table.

Table A-9. Bachelor's degrees in science and engineering in selected Asian countries, by field: 1975–90

Page 2 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total
Math and computer sciences							
1975 . . .	NA	NA	2,490	NA	NA	1,200	3,690
1976 . . .	NA	NA	2,529	NA	398	1,336	4,263
1977 . . .	NA	NA	2,755	NA	464	1,287	4,506
1978 . . .	NA	NA	2,703	NA	563	1,230	4,496
1979 . . .	NA	NA	2,829	NA	683	1,345	4,857
1980 . . .	NA	NA	2,918	NA	828	1,422	5,168
1981 . . .	NA	NA	3,152	NA	1,005	1,438	5,595
1982 . . .	14,804	NA	3,045	NA	1,393	1,536	20,778
1983 . . .	9,289	NA	3,148	NA	1,589	1,710	15,736
1984 . . .	4,610	NA	3,180	NA	1,918	1,710	11,418
1985 . . .	7,862	NA	3,532	NA	2,888	1,916	16,198
1986 . . .	8,462	NA	3,379	NA	2,839	2,134	16,814
1987 . . .	9,152	NA	3,572	NA	3,149	2,082	17,955
1988 . . .	10,884	NA	3,493	NA	5,824	2,414	22,615
1989 . . .	12,943	NA	3,395	NA	6,274	2,621	25,233
1990 . . .	12,915	NA	3,554	NA	6,676	2,818	25,963
Engineering							
1975 . . .	NA	14,073	66,512	236	7,155	5,000	92,976
1976 . . .	NA	15,057	68,126	241	7,272	5,142	95,838
1977 . . .	NA	16,110	70,431	290	7,858	5,258	99,947
1978 . . .	NA	17,237	72,466	240	8,919	5,559	104,421
1979 . . .	NA	17,236	75,409	272	10,124	6,315	109,356
1980 . . .	NA	18,100	74,737	288	11,492	6,463	111,080
1981 . . .	NA	19,007	76,370	323	13,044	7,299	116,043
1982 . . .	145,263	19,959	74,774	349	14,806	7,309	262,461
1983 . . .	89,726	20,960	70,824	585	20,636	7,320	210,050
1984 . . .	77,388	22,010	71,640	585	22,190	7,330	201,143
1985 . . .	63,132	21,088	72,560	769	23,539	7,703	188,791
1986 . . .	72,703	24,096	74,516	924	27,612	7,730	207,581
1987 . . .	92,994	27,057	77,077	907	27,600	7,508	233,143
1988 . . .	104,271	27,000	77,503	1,001	26,891	7,994	244,660
1989 . . .	116,915	28,000	77,009	1,105	28,141	8,007	259,177
1990 . . .	112,814	29,000	81,355	1,220	28,071	8,950	261,410

See explanatory information and SOURCES at end of table.

Table A-9. Bachelor's degrees in science and engineering in selected Asian countries, by field: 1975–90.

Page 3 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total
				Agricultural sciences			
1975 . . .	NA	4,814	9,480	NA	2,546	800	17,640
1976 . . .	NA	5,145	9,965	NA	2,680	898	18,689
1977 . . .	NA	5,499	10,455	NA	2,822	866	19,642
1978 . . .	NA	5,876	10,937	NA	2,971	961	20,745
1979 . . .	NA	6,280	12,794	NA	3,128	926	23,128
1980 . . .	NA	6,611	11,182	NA	3,293	977	22,063
1981 . . .	NA	6,958	11,555	NA	3,837	1,037	23,387
1982 . . .	32,911	7,325	11,016	NA	4,493	1,010	56,755
1983 . . .	15,817	7,710	10,658	NA	4,603	984	39,773
1984 . . .	15,015	8,116	11,189	NA	4,327	959	39,606
1985 . . .	15,525	8,257	10,928	NA	4,068	980	39,758
1986 . . .	17,136	7,414	10,991	NA	5,483	969	41,993
1987 . . .	18,213	7,810	11,266	NA	6,395	1,137	44,821
1988 . . .	18,920	7,827	10,584	NA	8,050	1,196	46,577
1989 . . .	19,654	7,684	10,252	NA	8,027	1,133	46,750
1990 . . .	20,349	7,774	11,733	NA	8,005	1,234	49,095

NOTES: Tables on degrees by field, A-9 to A-11, disaggregate fields of science more than table A-8. In degree tables by field, natural science includes only physical; biological; and earth, atmospheric, and oceanographic sciences. Agriculture and math and computer science are separated out. India data are estimated for 1988–90; Singapore data are estimated for 1990.

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; China: Government of the People's Republic of China, State Education Commission, Department of Planning and Construction, 1990, *Educational Statistics Yearbook of China* (Beijing); India: Government of India, University Grants Commission, 1990, *Annual Report for the Year 1988–89* (New Delhi), and Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); Singapore: University of Singapore, 1974–89, *Annual Report*, annual series; South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei); United States: National Science Foundation, 1992, *Science and Engineering Degrees: 1966–90, A Source Book*, NSF 92-326 (Washington, DC)

Table A-10. Advanced degrees (master's and doctoral) in science and engineering in selected Asian countries, by field: 1975–90

Page 1 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total
			Social and behavioral science				
1975	NA	NA	2,172	NA	NA	NA	2,172
1976	NA	NA	2,164	NA	161	207	2,532
1977	NA	NA	2,045	NA	118	239	2,402
1978	NA	NA	2,122	NA	145	228	2,495
1979	NA	NA	2,092	NA	178	194	2,464
1980	NA	NA	2,103	NA	218	229	2,550
1981	NA	NA	2,125	NA	267	579	2,971
1982	NA	NA	1,967	NA	249	464	2,680
1983	NA	NA	1,935	2	402	372	2,711
1984	NA	NA	2,003	4	527	298	2,832
1985	NA	NA	2,179	11	825	370	3,385
1986	NA	NA	2,175	7	848	372	3,402
1987	1,567	NA	2,282	6	823	430	5,108
1988	1,751	NA	2,421	7	798	452	5,429
1989	1,957	NA	2,560	6	816	286	5,625
1990	1,792	NA	4,981	6	916	277	7,972
			Natural science				
1975	NA	18,825	1,599	18	NA	NA	20,442
1976	NA	19,043	1,740	11	220	222	21,236
1977	NA	19,281	1,892	9	230	212	21,624
1978	NA	19,539	1,858	8	285	270	21,960
1979	NA	19,700	1,960	7	352	258	22,277
1980	68	20,369	1,977	6	436	294	23,150
1981	2,141	21,063	1,989	7	539	372	26,111
1982	618	21,781	2,021	2	667	359	25,447
1983	511	22,525	2,087	8	1,099	346	26,575
1984	231	23,295	2,102	11	1,187	333	27,159
1985	2,421	21,922	2,256	11	1,825	370	28,805
1986	1,595	22,877	2,243	13	1,661	421	28,810
1987	4,132	26,401	2,426	31	1,865	475	35,330
1988	4,660	25,074	2,579	46	1,255	566	34,180
1989	5,255	25,110	2,833	46	1,245	586	35,075
1990	5,299	26,500	5,412	50	1,365	748	39,374

See explanatory information and SOURCES at end of table.

Table A-10. Advanced degrees (master's and doctoral) in science and engineering in selected Asian countries, by field: 1975–90

Page 2 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total
			Math and computer sciences				
1975	NA	NA	277	NA	NA	NA	277
1976	NA	NA	217	NA	NA	84	301
1977	NA	NA	269	NA	NA	91	360
1978	NA	NA	267	NA	NA	104	371
1979	NA	NA	261	NA	NA	92	353
1980	NA	NA	261	NA	NA	93	354
1981	NA	NA	283	NA	NA	129	412
1982	NA	NA	264	NA	NA	165	429
1983	180	NA	308	NA	NA	164	652
1984	198	NA	337	NA	NA	164	699
1985	1,075	NA	346	NA	NA	188	1,609
1986	941	NA	340	NA	NA	272	1,553
1987	941	NA	392	NA	NA	278	1,611
1988	NA	NA	387	NA	399	307	1,093
1989	NA	NA	440	NA	392	418	1,250
1990	NA	NA	827	NA	596	465	1,888
			Engineering				
1975	NA	1,364	6,721	5	NA	NA	8,090
1976	NA	1,563	6,440	42	319	265	8,629
1977	NA	1,794	7,705	45	334	314	10,192
1978	NA	2,062	8,355	49	464	403	11,333
1979	NA	2,086	8,358	53	645	395	11,537
1980	205	2,091	7,879	57	896	485	11,613
1981	3,515	2,095	7,733	64	1,246	528	15,181
1982	793	2,100	8,061	72	1,731	634	13,391
1983	1,348	2,105	8,367	148	2,012	761	14,741
1984	1,011	2,110	8,952	132	2,191	914	15,310
1985	4,971	1,935	9,251	135	2,504	1,151	19,947
1986	5,026	2,675	10,303	155	2,844	1,362	22,365
1987	11,051	3,162	11,137	157	3,037	1,551	30,095
1988	12,850	2,829	11,956	151	3,852	1,868	33,506
1989	14,943	2,933	12,954	132	4,020	2,071	37,053
1990	14,027	3,050	24,910	150	4,014	2,407	48,558

See explanatory information and SOURCES at end of table.

Table A-10. Advanced degrees (master's and doctoral) in science and engineering in selected Asian countries, by field: 1975–90

Page 3 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total
			Agricultural sciences				
1975	NA	1,800	1,171	NA	NA	NA	2,971
1976	NA	2,087	1,145	NA	194	142	3,568
1977	NA	2,420	1,339	NA	257	157	4,173
1978	NA	2,806	1,460	NA	442	155	4,863
1979	NA	2,864	1,334	NA	470	140	4,808
1980	NA	2,946	1,315	NA	531	140	4,933
1981	311	3,031	1,318	NA	647	153	5,460
1982	121	3,120	1,258	NA	442	167	5,109
1983	167	3,214	1,362	NA	470	183	5,396
1984	53	3,312	2,139	NA	531	200	6,235
1985	1,026	5,738	2,301	NA	647	204	9,916
1986	788	5,941	2,380	NA	622	252	9,983
1987	1,161	3,659	2,382	NA	619	266	8,087
1988	1,400	5,384	2,563	NA	1,072	304	10,723
1989	1,688	5,739	2,837	NA	1,022	350	11,636
1990	1,461	6,300	5,400	NA	1,095	391	14,647

NOTES: India data are estimated for 1988-90; Singapore data are estimated for 1990.

KEY: NA = Not available

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; China: Government of the People's Republic of China, State Education Commission, Department of Planning and Construction, 1990, *Educational Statistics Yearbook of China* (Beijing); India: Government of India, University Grants Commission, 1990, *Annual Report for the Year 1988–89* (New Delhi), and Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); Singapore: University of Singapore, 1974–89, *Annual Report*, annual series; South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei)

Table A-11. Doctoral degrees in science and engineering in selected Asian countries, by field: 1975–90

Page 1 of 3

Year	China	India	Japan	South Korea	Taiwan	Total
			Social and behavioral science			
1975	NA	NA	444	NA	NA	444
1976	NA	NA	499	31	7	537
1977	NA	NA	451	23	13	487
1978	NA	NA	454	23	2	479
1979	NA	NA	446	24	6	476
1980	NA	NA	464	24	8	496
1981	NA	NA	523	25	10	558
1982	NA	NA	520	25	13	558
1983	NA	NA	459	41	15	515
1984	NA	NA	467	39	23	529
1985	NA	NA	523	50	16	589
1986	NA	NA	490	52	26	568
1987	NA	NA	489	102	22	613
1988	NA	NA	536	90	22	648
1989	62	NA	501	97	41	701
1990	114	NA	482	107	43	746
			Natural science			
1975	NA	1,484	449	NA	NA	1,933
1976	NA	1,651	456	29	2	2,138
1977	NA	1,837	526	22	4	2,389
1978	NA	2,044	462	30	7	2,543
1979	NA	2,261	515	41	4	2,821
1980	NA	2,385	536	55	6	2,982
1981	NA	2,516	555	75	8	3,154
1982	NA	2,654	511	102	5	3,272
1983	NA	2,800	506	83	8	3,397
1984	NA	2,954	460	124	14	3,552
1985	NA	2,838	535	212	20	3,605
1986	NA	2,840	498	201	22	3,561
1987	NA	3,038	522	277	35	3,872
1988	NA	3,074	507	207	35	3,823
1989	571	3,110	587	192	42	4,502
1990	652	3,500	568	170	47	4,937

See explanatory information and SOURCES at end of table.

Table A-11. Doctoral degrees in science and engineering in selected Asian countries, by field: 1975–90

Page 2 of 3

Year	China	India	Japan	South Korea	Taiwan	Total
			Math and computer sciences			
1975	NA	NA	45	NA	NA	45
1976	NA	NA	29	NA	0	29
1977	NA	NA	41	NA	0	41
1978	NA	NA	38	NA	0	38
1979	NA	NA	40	NA	1	41
1980	NA	NA	53	NA	1	54
1981	NA	NA	52	NA	1	53
1982	NA	NA	58	NA	3	61
1983	NA	NA	76	NA	4	80
1984	NA	NA	69	NA	2	71
1985	NA	NA	75	NA	4	79
1986	NA	NA	66	NA	13	79
1987	NA	NA	83	NA	14	97
1988	NA	NA	82	73	14	169
1989	NA	NA	88	105	18	211
1990	NA	NA	66	75	24	165
			Engineering			
1975	NA	136	576	NA	NA	712
1976	NA	135	558	20	8	721
1977	NA	135	672	14	3	824
1978	NA	134	591	20	3	748
1979	NA	176	665	29	8	878
1980	NA	179	665	42	10	896
1981	NA	182	697	60	15	955
1982	NA	185	634	87	15	921
1983	NA	189	591	97	14	891
1984	NA	192	575	120	31	918
1985	NA	194	559	197	59	1,009
1986	NA	215	599	273	83	1,170
1987	NA	225	642	270	98	1,235
1988	NA	229	736	346	98	1,409
1989	971	233	930	415	120	2,669
1990	1,054	250	948	439	165	2,856

See explanatory information and SOURCES at end of table.

Table A-11. Doctoral degrees in science and engineering in selected Asian countries, by field: 1975–90

Page 3 of 3

Year	China	India	Japan	South Korea	Taiwan	Total
			Agricultural sciences			
1975	NA	289	175	NA	NA	464
1976	NA	328	153	48	4	533
1977	NA	372	201	40	4	617
1978	NA	422	243	43	5	713
1979	NA	480	198	45	7	730
1980	NA	517	196	48	5	767
1981	NA	558	254	52	15	878
1982	NA	601	238	55	8	902
1983	NA	648	200	60	17	925
1984	NA	698	214	77	15	1,004
1985	NA	782	223	89	10	1,104
1986	NA	690	208	105	28	1,031
1987	NA	832	223	110	28	1,193
1988	NA	884	262	155	28	1,329
1989	75	939	332	175	36	1,557
1990	120	1,100	303	154	33	1,710

NOTE: India data are estimated for 1988–90.

KEY: NA = Not available

SOURCES: UNESCO, 1975–92, *Statistical Yearbook*, annual series, supplemented by national sources; China: Government of the People's Republic of China, State Education Commission, Department of Planning and Construction, 1990, *Educational Statistics Yearbook of China* (Beijing); India: Government of India, University Grants Commission, 1990, *Annual Report for the Year 1988–89* (New Delhi), and Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Government of Japan, Ministry of Education, Science, and Culture, 1975–90, *Monbusho Survey of Education*, annual series (Tokyo); Singapore: University of Singapore, 1974–89, *Annual Report*, annual series; South Korea: Government of the Republic of Korea, Ministry of Education, 1975–90, *Yearbook of Educational Statistics*, annual series (Seoul); Taiwan: Government of the Republic of China, Ministry of Education, 1975–90, *Educational Statistics of the Republic of China*, annual series (Taipei)

Table A-12. Ratio of science and engineering degrees to total bachelor's degrees in selected Asian countries and the United States, by field: 1975–90

Page 1 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	United States
				Natural science			
1975 . . .	NA	NA	0.06	0.20	NA	NA	0.13
1976 . . .	NA	0.16	.06	.21	0.17	0.14	.13
1977 . . .	NA	.16	.06	.14	.17	.13	.13
1978 . . .	NA	.16	.06	.14	.16	.13	.13
1979 . . .	NA	.17	.06	.19	.16	.13	.13
1980 . . .	NA	.18	.06	.22	.16	.13	.13
1981 . . .	NA	.21	.06	.21	.16	.13	.13
1982 . . .	0.21	.20	.06	.24	.17	.14	.13
1983 . . .	.16	.19	.06	.23	.15	.14	.13
1984 . . .	.17	.19	.06	.19	.14	.13	.13
1985 . . .	.18	.20	.06	.20	.13	.14	.14
1986 . . .	.17	.19	.06	.20	.11	.14	.14
1987 . . .	.17	.20	.06	.20	.11	.14	.13
1988 . . .	.16	.19	.06	.19	.13	.15	.12
1989 . . .	.16	.19	.06	.20	.14	.15	.11
1990 . . .	.17	NA	.06	NA	.14	.15	.10
				Engineering			
1975 . . .	NA	NA	0.21	0.10	NA	NA	0.04
1976 . . .	NA	0.02	.21	.10	0.21	0.18	.04
1977 . . .	NA	.02	.21	.12	.21	.18	.04
1978 . . .	NA	.03	.20	.10	.22	.18	.05
1979 . . .	NA	.03	.20	.10	.22	.20	.06
1980 . . .	NA	.03	.20	.11	.23	.19	.06
1981 . . .	NA	.04	.20	.15	.23	.23	.07
1982 . . .	0.40	.04	.20	.15	.24	.22	.07
1983 . . .	.36	.04	.19	.20	.27	.22	.07
1984 . . .	.38	.04	.19	.16	.24	.21	.08
1985 . . .	.31	.03	.19	.18	.20	.22	.08
1986 . . .	.32	.04	.20	.19	.20	.21	.08
1987 . . .	.37	.04	.20	.18	.18	.19	.07
1988 . . .	.37	.04	.20	.19	.17	.21	.07
1989 . . .	.38	.04	.20	.19	.17	.20	.06
1990 . . .	.41	NA	.20	NA	.17	.21	.06

See explanatory information and SOURCES at end of table.

Table A-12. Ratio of science and engineering degrees to total bachelor's degrees in selected Asian countries and the United States, by field: 1975–90

Page 2 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	United States
			Natural science and engineering				
1975 . . .	NA	NA	0.27	0.29	NA	NA	0.17
1976 . . .	NA	0.19	.27	.31	0.38	0.32	.17
1977 . . .	NA	.19	.27	.27	.38	.31	.18
1978 . . .	NA	.19	.26	.24	.38	.32	.18
1979 . . .	NA	.20	.26	.29	.38	.32	.19
1980 . . .	NA	.21	.26	.33	.38	.32	.19
1981 . . .	NA	.25	.26	.36	.39	.36	.19
1982 . . .	0.61	.24	.26	.39	.40	.36	.20
1983 . . .	.51	.23	.25	.43	.41	.35	.20
1984 . . .	.55	.22	.26	.35	.38	.34	.21
1985 . . .	.49	.23	.26	.38	.33	.36	.22
1986 . . .	.49	.23	.26	.39	.31	.35	.21
1987 . . .	.54	.24	.27	.37	.30	.34	.21
1988 . . .	.54	.23	.27	.38	.30	.36	.19
1989 . . .	.54	.23	.27	.39	.30	.35	.18
1990 . . .	.58	NA	.27	NA	.31	.36	.16
			Social science				
1975 . . .	NA	NA	0.43	NA	NA	NA	0.18
1976 . . .	NA	NA	.43	NA	0.04	0.10	.17
1977 . . .	NA	NA	.42	NA	.04	.10	.16
1978 . . .	NA	NA	.42	NA	.04	.09	.15
1979 . . .	NA	NA	.42	NA	.03	.09	.15
1980 . . .	NA	NA	.42	NA	.03	.08	.14
1981 . . .	NA	NA	.42	NA	.03	.09	.14
1982 . . .	NA	NA	.42	NA	.03	.09	.14
1983 . . .	NA	NA	.41	NA	.06	.09	.13
1984 . . .	NA	NA	.41	0.02	.04	.09	.13
1985 . . .	NA	NA	.40	.02	.05	.09	.13
1986 . . .	NA	NA	.40	.02	.06	.08	.13
1987 . . .	0.06	NA	.39	.02	.06	.09	.13
1988 . . .	.07	NA	.39	.02	.06	.09	.14
1989 . . .	.08	NA	.39	.02	.05	.08	.14
1990 . . .	.08	NA	.39	NA	.06	.07	.15

See explanatory information and SOURCES at end of table.

Table A-12. Ratio of science and engineering degrees to total bachelor's degrees in selected Asian countries and the United States, by field: 1975–90

Page 3 of 3

Year	China	India	Japan	Singapore	South Korea	Taiwan	United States
				Science and engineering			
1975 ...	NA	NA	0.70	0.29	NA	NA	0.34
1976 ...	NA	0.19	.70	.31	0.42	0.41	.34
1977 ...	NA	.19	.69	.27	.41	.41	.34
1978 ...	NA	.19	.69	.24	.41	.41	.33
1979 ...	NA	.20	.69	.29	.41	.41	.33
1980 ...	NA	.21	.68	.33	.41	.40	.33
1981 ...	NA	.25	.67	.36	.42	.45	.33
1982 ...	0.61	.24	.67	.39	.43	.45	.33
1983 ...	.51	.23	.66	.43	.47	.44	.33
1984 ...	.55	.22	.66	.38	.42	.43	.34
1985 ...	.49	.23	.66	.40	.38	.45	.34
1986 ...	.49	.23	.66	.41	.37	.44	.34
1987 ...	.60	.24	.66	.40	.35	.42	.34
1988 ...	.61	.23	.66	.40	.36	.44	.33
1989 ...	.62	.23	.66	.41	.35	.42	.32
1990 ...	.67	NA	.66	NA	.37	.43	.31

NOTES: China reports social science degrees from 1987 to 1989. India does not report social science degrees.

KEY: NA = Not available

SOURCE: Computed, table A-3

Table A-13. Bachelor's degrees in natural science and engineering as a percentage of 22-year-olds in selected Asian countries and the United States: 1975–90

Page 1 of 1

Year	China	India	Japan	Singapore	South Korea	Taiwan	United States
1975	NA	1.07	4.65	1.40	2.07	NA	4.02
1976	NA	1.08	4.94	1.41	2.00	2.59	3.85
1977	NA	1.08	5.27	1.17	2.03	2.53	3.72
1978	NA	1.09	5.60	1.06	2.13	2.61	3.61
1979	NA	1.02	6.09	1.40	2.24	2.76	3.51
1980	NA	1.01	6.17	1.45	2.37	2.82	4.10
1981	NA	1.01	6.26	1.31	2.67	3.01	4.24
1982	1.19	1.01	6.09	1.54	3.03	2.99	4.41
1983	0.67	1.02	5.77	2.07	3.82	3.01	4.60
1984	.55	1.02	5.85	2.16	4.10	2.99	4.82
1985	.47	1.07	5.88	2.65	4.54	3.25	5.04
1986	.51	1.08	5.90	3.15	5.02	3.36	5.16
1987	.59	1.13	6.00	3.34	5.18	3.40	5.13
1988	.63	1.11	5.88	3.56	5.66	3.69	4.90
1989	.79	1.12	5.73	4.20	5.91	3.79	4.76
1990	.83	1.13	5.96	NA	5.97	4.17	4.52

NOTES: Natural science includes physical; biological; earth, atmospheric, and oceanographic; agricultural; and math and computer sciences. National data were reconfigured to include only fields of study corresponding to classification of programs used in surveys of higher education in the United States.

KEY: NA = Not available

SOURCE: Computed, tables A-3 and A-15

Table A-14. Total population in selected Asian countries: 1975–2000 (projected)

[In thousands]

Page 1 of 1

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total
1975 . .	916,395	613,459	111,940	2,263	35,281	16,000	1,695,337
1976 . .	929,010	627,569	112,892	2,292	35,832	16,316	1,723,911
1977 . .	941,800	642,004	113,852	2,322	36,392	16,637	1,753,007
1978 . .	954,765	656,771	114,820	2,352	36,960	16,965	1,782,635
1979 . .	967,909	671,878	115,797	2,383	37,538	17,300	1,812,805
1980 . .	981,234	687,332	116,782	2,414	38,124	17,641	1,843,528
1981 . .	994,235	702,235	117,566	2,474	38,646	17,930	1,873,086
1982 . .	1,007,408	717,460	118,355	2,536	39,175	18,224	1,903,158
1983 . .	1,020,755	733,016	119,149	2,600	39,711	18,523	1,933,754
1984 . .	1,034,280	748,909	119,949	2,664	40,255	18,826	1,964,884
1985 . .	1,047,983	765,147	120,754	2,731	40,806	19,135	1,996,556
1986 . .	1,064,591	781,322	121,302	2,783	41,197	19,365	2,030,561
1987 . .	1,081,463	797,839	121,853	2,837	41,591	19,598	2,065,180
1988 . .	1,098,601	814,705	122,406	2,891	41,989	19,833	2,100,426
1989 . .	1,116,012	831,928	122,961	2,947	42,391	20,072	2,136,310
1990 . .	1,133,698	849,515	123,519	3,003	42,797	20,313	2,172,845
1991 . .	1,150,104	865,020	123,954	3,045	43,180	20,491	2,205,793
1992 . .	1,166,747	880,808	124,391	3,088	43,566	20,670	2,239,269
1993 . .	1,183,631	896,884	124,829	3,131	43,956	20,851	2,273,281
1994 . .	1,200,759	913,253	125,269	3,175	44,349	21,034	2,307,838
1995 . .	1,218,135	929,921	125,710	3,219	44,746	21,218	2,342,949
1996 . .	1,232,857	944,683	126,084	3,249	45,119	21,384	2,373,377
1997 . .	1,247,758	959,680	126,459	3,279	45,495	21,552	2,404,222
1998 . .	1,262,838	974,915	126,835	3,309	45,874	21,720	2,435,492
1999 . .	1,278,101	990,392	127,213	3,339	46,256	21,891	2,467,191
2000 . .	1,293,548	1,006,114	127,591	3,370	46,642	22,062	2,499,327

SOURCE: Bos, Edward, My T. Vu, and Ann Levin, 1992, *East Asia and Pacific Region, South Asia Region Population Projections*, 1992–93 edition (Washington, DC: The World Bank, Population and Human Resources Department)

Table A-15. Twenty- to twenty-four-year-old population in selected Asian countries: 1975–2010 (projected)

[In thousands]

Page 1 of 1

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total
1975	89,178	52,885	9,189	250	3,089	1,710	156,300
1976	88,370	54,634	8,916	259	3,269	1,790	157,238
1977	87,569	56,441	8,652	267	3,460	1,816	158,206
1978	86,776	58,308	8,395	277	3,663	1,854	159,273
1979	85,990	60,237	8,146	286	3,877	1,895	160,430
1980	85,211	62,229	7,904	296	4,103	1,917	161,660
1981	89,116	63,681	7,959	298	4,133	1,936	167,124
1982	93,201	65,167	8,015	300	4,164	1,976	172,823
1983	97,472	66,688	8,071	302	4,194	1,994	178,722
1984	101,940	68,244	8,127	304	4,225	2,002	184,843
1985	106,612	69,837	8,184	306	4,256	1,950	191,145
1986	110,434	71,349	8,329	297	4,264	1,931	196,603
1987	114,392	72,893	8,477	288	4,272	1,911	202,233
1988	118,493	74,470	8,628	279	4,279	1,892	208,042
1989	122,740	76,082	8,781	270	4,287	1,874	214,035
1990	127,140	77,729	8,937	262	4,295	1,855	220,218
1991	126,109	79,529	9,137	260	4,326	1,832	221,193
1992	125,086	81,372	9,342	257	4,358	1,809	222,224
1993	124,072	83,256	9,551	255	4,390	1,786	223,310
1994	123,066	85,185	9,765	252	4,422	1,764	224,454
1995	122,068	87,158	9,984	250	4,454	1,742	225,656
1996	116,094	87,594	9,664	242	4,334	1,773	219,701
1997	110,412	88,033	9,354	234	4,217	1,804	214,054
1998	105,008	88,473	9,054	227	4,104	1,836	208,702
1999	99,869	88,916	8,763	220	3,993	1,869	203,630
2000	94,981	89,361	8,482	213	3,886	1,902	198,825
2001	94,112	92,010	8,255	216	3,829	1,928	200,351
2002	93,251	94,738	8,035	220	3,773	1,955	201,972
2003	92,398	97,546	7,820	224	3,718	1,982	203,688
2004	91,553	100,438	7,611	227	3,664	2,009	205,502
2005	90,715	103,415	7,408	231	3,610	2,037	207,416
2006	95,379	104,983	7,282	238	3,537	1,958	213,378
2007	100,284	106,575	7,158	246	3,465	1,883	219,611
2008	105,440	108,190	7,036	254	3,395	1,810	226,126
2009	110,862	109,831	6,917	262	3,326	1,740	232,938
2010	116,562	111,496	6,799	271	3,259	1,673	240,060

SOURCE: Bos, Edward, My T. Vu, and Ann Levin, 1992, *East Asia and Pacific Region, South Asia Region Population Projections*, 1992–93 edition (Washington, DC: The World Bank, Population and Human Resources Department)

Table A-16. Overall R&D in selected Asian countries and the United States: 1975–90

Page 1 of 4

Country (unit of currency)	Year	R&D in millions of currency units				Overall R&D as a percentage of gross domestic product
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
India (rupee)	1975 . . .	3,568	9,034	976	1,702	0.5
	1976 . . .	3,741	9,043	1,013	1,704	.4
	1977 . . .	4,306	9,854	1,167	1,857	.5
	1978 . . .	5,286	11,782	1,495	2,220	.5
	1979 . . .	6,385	12,218	1,693	2,302	.6
	1980 . . .	7,605	13,052	1,922	2,460	.6
	1981 . . .	9,407	14,644	2,308	2,759	.6
	1982 . . .	12,061	17,475	2,905	3,293	.7
	1983 . . .	13,811	18,446	3,148	3,476	.7
	1984 . . .	17,816	22,137	3,803	4,172	.8
	1985 . . .	20,687	23,950	4,199	4,513	.8
	1986 . . .	24,354	26,439	4,752	4,982	.8
	1987 . . .	28,531	28,531	5,377	5,377	.9
	1988 . . .	33,473	30,927	6,096	5,828	.8
	1989 . . .	37,257	32,034	NA	6,037	.8
	1990 . . .	41,864	32,319	NA	6,090	.8
Japan (yen)	1975 . . .	2,737,000	3,834,828	9,789	18,296	1.8
	1976 . . .	3,054,400	3,992,396	10,770	19,048	1.8
	1977 . . .	3,358,920	4,124,347	11,882	19,677	1.8
	1978 . . .	3,725,080	4,392,906	13,463	20,959	1.8
	1979 . . .	4,217,280	4,827,237	16,164	23,031	1.9
	1980 . . .	4,826,320	5,319,981	19,305	25,382	2.0
	1981 . . .	5,502,794	5,880,095	23,238	28,054	2.1
	1982 . . .	6,014,874	6,307,523	26,591	30,093	2.2
	1983 . . .	6,621,186	6,893,383	29,839	32,888	2.4
	1984 . . .	7,302,421	7,510,003	33,329	35,830	2.5
	1985 . . .	8,274,717	8,382,288	38,185	39,992	2.6
	1986 . . .	8,562,752	8,529,074	39,661	40,692	2.6
	1987 . . .	9,162,095	9,162,095	43,712	43,712	2.7
	1988 . . .	9,931,859	9,873,379	48,781	47,106	2.7
	1989 . . .	11,075,422	10,840,002	55,433	51,718	2.9
	1990 . . .	12,281,229	11,725,622	62,787	55,943	2.9

See explanatory information and SOURCES at end of table.

Table A-16. Overall R&D in selected Asian countries and the United States: 1975–90

Page 2 of 4

Country (unit of currency)	Year	R&D in millions of currency units				Overall R&D as a percentage of gross domestic product
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
Singapore (Singapore dollar)	1975 . . .	NA	NA	NA	NA	NA
	1976 . . .	NA	NA	NA	NA	NA
	1977 . . .	38	51	23	28	0.2
	1978 . . .	46	61	29	34	.3
	1979 . . .	55	70	36	39	.3
	1980 . . .	67	76	43	42	.3
	1981 . . .	81	86	53	48	.3
	1982 . . .	112	114	80	63	.3
	1983 . . .	155	151	97	84	.4
	1984 . . .	214	208	118	116	.5
	1985 . . .	258	254	148	141	.7
	1986 . . .	311	313	173	174	.8
	1987 . . .	375	375	208	208	.9
	1988 . . .	431	414	240	230	.9
	1989 . . .	497	465	276	258	.9
	1990 . . .	572	525	318	292	.9
South Korea (won)	1975 . . .	NA	NA	NA	NA	NA
	1976 . . .	60,900	195,357	242	378	0.4
	1977 . . .	108,286	297,996	393	577	.6
	1978 . . .	152,418	342,458	493	663	.6
	1979 . . .	174,039	326,323	505	632	.6
	1980 . . .	211,727	319,843	508	620	.6
	1981 . . .	293,131	378,865	643	734	.6
	1982 . . .	457,688	553,278	996	1,072	.8
	1983 . . .	621,749	716,626	1,298	1,388	1.0
	1984 . . .	833,894	924,139	1,694	1,790	1.1
	1985 . . .	1,155,156	1,230,241	2,263	2,383	1.4
	1986 . . .	1,523,279	1,578,105	2,955	3,057	1.6
	1987 . . .	1,877,965	1,877,965	3,638	3,638	1.7
	1988 . . .	2,347,415	2,216,309	4,533	4,294	1.8
	1989 . . .	2,705,104	2,439,404	NA	4,726	1.9
	1990 . . .	3,210,486	2,604,088	NA	5,045	1.9

See explanatory information and SOURCES at end of table.

Table A-16. Overall R&D in selected Asian countries and the United States: 1975–90

Page 3 of 4

Country (unit of currency)	Year	R&D in millions of currency units				Overall R&D as a percentage of gross domestic product
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
Taiwan (New Taiwanese dollar)	1975 . . .	NA	NA	NA	NA	NA
	1976 . . .	NA	NA	NA	NA	NA
	1977 . . .	NA	NA	NA	NA	NA
	1978 . . .	6,407	10,339	242	388	0.6
	1979 . . .	9,908	14,340	370	539	.8
	1980 . . .	10,562	13,155	368	494	.7
	1981 . . .	16,413	18,247	550	685	.9
	1982 . . .	16,864	18,121	579	681	.9
	1983 . . .	19,200	20,241	660	760	.9
	1984 . . .	22,443	23,446	781	880	1.0
	1985 . . .	25,397	26,373	896	990	1.0
	1986 . . .	28,701	28,842	1,018	1,083	1.0
	1987 . . .	36,779	36,779	1,381	1,381	1.1
	1988 . . .	43,839	43,373	1,672	1,629	1.3
	1989 . . .	54,789	52,556	NA	1,974	1.4
	1990 . . .	71,548	65,938	NA	2,476	1.7
China (yuan)	1990 . . .	12,695	10,458	NA	21,465	0.7

See explanatory information and SOURCES at end of table.

Table A-16. Overall R&D in selected Asian countries and the United States: 1975–90

Year	United States: Constant 1987 dollars	United States: Overall R&D as a percentage of gross domestic product	Total Asian countries: Constant 1987 $PPPs [1]	Total Asian countries: Overall R&D as a percentage of gross domestic product
1975 . . .	72,256	2.2	19,998	0.7
1976 . . .	75,065	2.2	21,130	.7
1977 . . .	76,758	2.2	22,140	.7
1978 . . .	80,091	2.2	24,264	.7
1979 . . .	84,115	2.2	26,542	.8
1980 . . .	87,666	2.3	28,997	.8
1981 . . .	91,452	2.4	32,280	.8
1982 . . .	95,589	2.5	35,202	.9
1983 . .	102,310	2.6	38,597	1.0
1984 . . .	111,137	2.7	42,788	1.0
1985 . . .	120,624	2.8	48,020	1.1
1986 . . .	123,267	2.8	49,989	1.1
1987 . . .	125,353	2.8	54,316	1.1
1988 . . .	128,848	2.7	59,086	1.1
1989 . . .	129,888	2.7	64,712	1.1
1990 . . .	129,545	2.7	91,311	1.5

(1) $PPPs = purchasing power parity dollars

KEY: NA = Not available

SOURCES: China: Government of the People's Republic of China, State Science and Technology Commission, Division of Statistics, Department of Planning; India: Government of India, Department of Science and Technology, 1991, *Pocket Data Book, 1991* (New Delhi), and Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Organization for Economic Cooperation and Development, 1992, *Main Science and Technology Indicators* (Paris); Singapore: Government of Singapore, National Science and Technology Board, 1990, *National Survey of R&D Expenditures and Manpower*, and Government of Singapore, Science Council of Singapore, 1982–88, *National Survey of R&D Expenditures and Manpower*; South Korea: Government of the Republic of Korea, Ministry of Science and Technology, 1990, *1989 Report on the Survey of Research and Development in Science and Technology* (Seoul); Taiwan: Government of the Republic of China, National Science Council, 1989–90, *Indicators of Science and Technology*, annual series (Taipei); United States: National Science Foundation, 1992, *National Patterns of R&D Resources: 1992*, NSF 92-330 (Washington, DC)

Table A-17. R&D in selected Asian countries and the United States, by source of funds: 1975–90

Page 1 of 8

Country (unit of currency)	Year	R&D in millions of currency units				Government percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Government				
India (rupee)	1975	2,882	7,297	788	1,375	80.8
	1976	2,939	7,104	796	1,339	78.6
	1977	3,349	7,664	908	1,444	77.8
	1978	3,975	8,860	1,124	1,670	75.2
	1979	4,730	9,050	1,254	1,705	74.1
	1980	5,534	9,498	1,399	1,790	72.8
	1981	6,861	10,680	1,683	2,013	72.9
	1982	8,866	12,845	2,136	2,421	73.5
	1983	10,116	13,511	2,306	2,546	73.2
	1984	13,772	17,113	2,940	3,225	77.3
	1985	16,182	18,734	3,285	3,530	78.2
	1986	19,081	20,715	3,723	3,904	78.3
	1987	22,543	22,543	4,248	4,248	79.0
	1988	25,875	23,907	4,712	4,505	77.3
	1989	28,223	24,267	NA	4,573	75.8
	1990	32,161	24,828	NA	4,679	76.8
Japan (yen)	1975	812,274	1,138,082	2,905	5,430	29.7
	1976	898,000	1,173,773	3,166	5,600	29.4
	1977	992,506	1,218,677	3,511	5,814	29.5
	1978	1,121,454	1,322,507	4,053	6,310	30.1
	1979	1,240,144	1,419,510	4,753	6,772	29.4
	1980	1,347,459	1,485,284	5,390	7,086	27.9
	1981	1,370,196	1,464,144	5,786	6,985	24.9
	1982	1,413,495	1,482,268	6,249	7,072	23.5
	1983	1,450,040	1,509,651	6,535	7,203	21.9
	1984	1,496,996	1,539,551	6,832	7,345	20.5
	1985	1,580,471	1,601,017	7,293	7,638	19.1
	1986	1,661,174	1,654,640	7,694	7,894	19.4
	1987	1,795,771	1,795,771	8,568	8,568	19.6
	1988	1,797,666	1,787,082	8,829	8,526	18.1
	1989	1,860,671	1,821,120	9,313	8,689	16.8
	1990	1,989,559	1,899,551	10,172	9,063	16.2

See explanatory information and SOURCES at end of table.

Table A-17. R&D in selected Asian countries and the United States, by source of funds: 1975–90

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Country (unit of currency)	Year	R&D in millions of currency units				Government percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Government				
Singapore (Singapore dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	11	15	7	8	24.1
	1979	16	20	10	11	28.7
	1980	23	26	15	14	34.3
	1981	33	35	22	19	40.9
	1982	47	48	34	27	42.3
	1983	68	66	43	37	43.7
	1984	97	94	53	52	45.2
	1985	108	106	62	59	41.8
	1986	120	121	67	67	38.7
	1987	134	134	74	74	35.8
	1988	168	161	93	89	38.8
	1989	210	196	116	109	42.2
	1990	262	240	146	134	45.8
South Korea (won)	1975	NA	NA	NA	NA	NA
	1976	39,181	125,686	156	244	64.3
	1977	51,256	141,053	186	273	47.3
	1978	73,722	165,641	239	321	48.4
	1979	91,322	171,229	265	332	52.5
	1980	105,459	159,310	253	309	49.8
	1981	121,726	157,328	267	305	41.5
	1982	187,898	227,141	409	440	41.1
	1983	169,554	195,428	354	379	27.3
	1984	171,595	190,165	349	368	20.6
	1985	222,936	237,427	437	460	19.3
	1986	289,444	299,862	561	581	19.0
	1987	382,011	382,011	740	740	20.3
	1988	415,825	392,601	803	761	17.7
	1989	461,750	416,396	NA	807	17.1
	1990	510,789	414,311	NA	803	15.9

See explanatory notes and SOURCES at end of table.

Table A-17. R&D in selected Asian countries and the United States, by source of funds: 1975–90

Page 3 of 8

Country (unit of currency)	Year	R&D in millions of currency units				Government percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Government				
Taiwan (New Taiwanese dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	NA	NA	NA	NA	NA
	1979	NA	NA	NA	NA	NA
	1980	4,133	5,148	144	193	39.1
	1981	6,014	6,686	202	251	36.6
	1982	7,261	7,802	249	293	43.1
	1983	8,456	8,915	291	335	44.0
	1984	10,632	11,107	370	417	47.4
	1985	11,566	12,011	408	451	45.5
	1986	12,092	12,151	429	456	42.1
	1987	13,256	13,256	498	498	36.0
	1988	19,523	19,315	745	725	44.5
	1989	19,601	18,802	NA	706	35.8
	1990	32,772	30,202	NA	1,134	45.8
China (yuan)	1990	7,617	6,275	NA	12,879	60.0

See explanatory information and SOURCES at end of table.

Table A-17. R&D in selected Asian countries and the United States, by source of funds: 1975–90

Page 4 of 8

Year	United States: Constant 1987 dollars	United States: Government percentage of total R&D	Total Asian countries: Constant 1987 $PPPs [1]	Total Asian countries: Government percentage of total R&D
1975	38,060	51.4	6,805	34.0
1976	38,879	51.0	7,182	34.0
1977	38,992	50.5	7,532	34.0
1978	40,079	49.6	8,308	34.2
1979	41,435	48.8	8,821	34.2
1980	41,741	47.1	9,392	32.4
1981	42,964	46.5	9,573	29.7
1982	43,780	45.7	10,252	29.1
1983	46,923	45.8	10,499	27.2
1984	50,239	45.1	11,408	26.7
1985	55,260	45.8	12,139	25.2
1986	55,883	45.4	12,902	25.8
1987	57,904	46.2	14,128	26.0
1988	59,162	45.8	14,606	24.7
1989	57,864	44.5	14,883	23.0
1990	56,736	43.7	28,691	31.4

See explanatory information and SOURCES at end of table.

Table A-17. R&D in selected Asian countries and the United States, by source of funds: 1975–90

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Country (unit of currency)	Year	R&D in millions of currency units				Industry percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Industry				
India (rupee)	1975	686	1,737	188	327	19.2
	1976	802	1,939	217	365	21.4
	1977	957	2,190	259	413	22.2
	1978	1,311	2,922	371	551	24.8
	1979	1,655	3,167	439	597	25.9
	1980	2,071	3,554	524	670	27.2
	1981	2,546	3,963	625	747	27.1
	1982	3,195	4,629	770	872	26.5
	1983	3,695	4,935	842	930	26.8
	1984	4,044	5,025	863	947	22.7
	1985	4,505	5,216	914	983	21.8
	1986	5,273	5,724	1,029	1,079	21.7
	1987	5,988	5,988	1,128	1,128	21.0
	1988	7,490	6,920	1,364	1,304	22.4
	1989	8,909	7,660	NA	1,444	23.9
	1990	9,568	7,386	NA	1,392	22.9
Japan (yen)	1975	1,715,604	2,403,744	6,136	11,468	62.7
	1976	1,924,345	2,515,305	6,785	12,001	63.0
	1977	2,138,892	2,626,300	7,566	12,530	63.7
	1978	2,330,556	2,748,374	8,423	13,112	62.6
	1979	2,697,945	3,088,156	10,341	14,734	64.0
	1980	3,194,604	3,521,364	12,778	16,800	66.2
	1981	3,725,392	3,980,825	15,732	18,992	67.7
	1982	4,162,293	4,364,806	18,401	20,824	69.2
	1983	4,681,179	4,873,622	21,096	23,252	70.7
	1984	5,279,650	5,429,732	24,097	25,905	72.3
	1985	6,123,291	6,202,893	28,257	29,594	74.0
	1986	6,310,748	6,285,927	29,230	29,990	73.7
	1987	6,734,140	6,734,140	32,129	32,129	73.5
	1988	7,488,622	7,444,528	36,781	35,518	75.4
	1989	8,539,150	8,357,642	42,738	39,874	77.1
	1990	9,567,077	9,134,260	48,911	43,579	77.9

See explanatory information and SOURCES at end of table.

Table A-17. R&D in selected Asian countries and the United States, by source of funds: 1975–90

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Country (unit of currency)	Year	R&D in millions of currency units				Industry percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Industry				
Singapore (Singapore dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	27	35	17	20	58.4
	1979	32	41	21	23	58.7
	1980	39	45	25	25	58.9
	1981	48	51	31	28	59.1
	1982	65	66	46	36	57.6
	1983	87	85	55	47	56.2
	1984	117	114	65	63	54.8
	1985	149	147	86	81	57.8
	1986	190	191	105	106	61.0
	1987	241	241	134	134	64.3
	1988	262	251	146	140	60.7
	1989	285	267	158	148	57.4
	1990	310	285	172	158	54.2
South Korea (won)	1975	NA	NA	NA	NA	NA
	1976	21,438	68,769	85	133	35.2
	1977	56,580	155,705	205	302	52.3
	1978	77,971	175,188	252	339	51.2
	1979	79,248	148,590	230	288	45.5
	1980	102,445	154,757	246	300	48.4
	1981	165,226	213,551	362	414	56.4
	1982	268,747	324,876	585	629	58.7
	1983	451,047	519,876	941	1,007	72.5
	1984	655,722	726,685	1,332	1,408	78.6
	1985	930,263	990,730	1,822	1,919	80.5
	1986	1,232,579	1,276,942	2,391	2,474	80.9
	1987	1,494,975	1,494,975	2,896	2,896	79.6
	1988	1,931,207	1,823,347	3,730	3,533	82.3
	1989	2,242,234	2,021,998	NA	3,917	82.9
	1990	2,699,697	2,189,777	NA	4,242	84.1

See explanatory information and SOURCES at end of table.

Table A-17. R&D in selected Asian countries and the United States, by source of funds: 1975–90

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Country (unit of currency)	Year	R&D in millions of currency units				Industry percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Industry				
Taiwan (New Taiwanese dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	NA	NA	NA	NA	NA
	1979	NA	NA	NA	NA	NA
	1980	5,873	7,315	204	275	55.6
	1981	9,520	10,584	319	397	58.0
	1982	9,036	9,709	310	365	53.6
	1983	10,209	10,763	351	404	53.2
	1984	11,299	11,804	393	443	50.3
	1985	13,133	13,638	463	512	51.7
	1986	16,272	16,352	577	614	56.7
	1987	22,950	22,950	862	862	62.4
	1988	23,685	23,433	903	880	54.0
	1989	33,819	32,441	NA	1,218	61.7
	1990	36,990	34,090	NA	1,280	51.7
China (yuan)	1990	5,078	4,183	NA	8,586	40.0

See explanatory information and SOURCES at end of table.

Table A-17. R&D in selected Asian countries and the United States, by source of funds: 1975–90

Page 8 of 8

Year	United States		Total Asian countries	
	Constant 1987 dollars	Industry percentage of total R&D	Constant 1987 $PPPs [1]	Industry percentage of total R&D
1975	32,161	44.9	11,796	59.0
1976	33,851	45.3	12,499	59.2
1977	35,133	45.9	13,244	59.8
1978	37,237	46.6	14,022	57.8
1979	39,789	47.5	15,641	58.9
1980	43,107	49.4	18,069	62.3
1981	45,580	50.0	20,579	63.7
1982	48,582	50.9	22,727	64.6
1983	51,917	50.8	25,641	66.4
1984	57,336	51.6	28,767	67.2
1985	61,436	50.9	33,090	68.9
1986	62,996	51.1	34,263	68.5
1987	62,642	50.0	37,149	68.4
1988	64,654	50.2	41,374	70.0
1989	66,510	51.2	46,601	72.0
1990	66,890	51.7	59,238	66.9

(1) $PPPs = Purchasing power parity dollars

NOTES: Chinese data include public enterprises; Taiwan data include public industry.

KEY: NA = Not available

SOURCES: China: Government of the People's Republic of China, State Science and Technology Commission, Division of Statistics, Department of Planning); India: Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Organization for Economic Cooperation and Development, 1992, *Main Science and Technology Indicators* (Paris); Singapore: Government of Singapore, National Science and Technology Board, 1990, *National Survey of R&D Expenditures and Manpower*, and Government of Singapore, Science Council of Singapore, 1982–88, *National Survey of R&D Expenditures and Manpower*; South Korea: Government of the Republic of Korea, Ministry of Science and Technology, 1990, *1989 Report on the Survey of Research and Development in Science and Technology* (Seoul); Taiwan: Government of the Republic of China, National Science Council, 1987, *Science and Technology Databook*, (Taipei); United States: National Science Foundation, 1992, *National Patterns of R&D Resources: 1992*, NSF 92-330 (Washington, DC)

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975–90

Page 1 of 14

Country (unit of currency)	Year	R&D in millions of currency units				Government institutes percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Government institutes				
India (rupee)	1975	2,882	7,297	788	1,375	80.8
	1976	2,939	7,104	796	1,339	78.6
	1977	3,349	7,664	908	1,444	77.8
	1978	3,975	8,860	1,124	1,670	75.2
	1979	4,730	9,050	1,254	1,705	74.1
	1980	5,534	9,498	1,399	1,790	72.8
	1981	6,861	10,680	1,683	2,013	72.9
	1982	8,866	12,845	2,136	2,421	73.5
	1983	10,116	13,511	2,306	2,546	73.2
	1984	13,772	17,113	2,940	3,225	77.3
	1985	16,182	18,734	3,285	3,530	78.2
	1986	19,081	20,715	3,723	3,904	78.3
	1987	22,543	22,543	4,248	4,248	79.0
	1988	25,875	23,907	4,712	4,505	77.3
	1989	28,223	24,267	NA	4,573	75.8
	1990	32,161	24,828	NA	4,679	76.8
Japan (yen)	1975	364,005	510,010	1,302	2,433	13.3
	1976	402,537	526,155	1,420	2,510	13.2
	1977	440,690	541,114	1,559	2,581	13.1
	1978	502,956	593,125	1,818	2,830	13.5
	1979	565,787	647,618	2,169	3,089	13.4
	1980	618,377	681,628	2,473	3,252	12.8
	1981	661,397	706,746	2,793	3,372	12.0
	1982	673,082	705,830	2,975	3,367	11.2
	1983	691,358	719,780	3,116	3,434	10.4
	1984	725,685	746,314	3,312	3,560	9.9
	1985	810,759	821,299	3,742	3,918	9.8
	1986	840,223	836,918	3,892	3,993	9.8
	1987	943,178	943,178	4,499	4,499	10.3
	1988	935,256	929,749	4,592	4,435	9.4
	1989	953,755	933,482	4,773	4,453	8.6
	1990	976,867	932,673	4,994	4,449	8.0

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

Page 2 of 14

Country (unit of currency)	Year	R&D in millions of currency units				Government institutes percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs [1]	Constant 1987 $PPPs [1]	
Government institutes						
Singapore (dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	4	5	3	3	9.0
	1979	6	7	4	4	10.7
	1980	9	10	5	5	12.9
	1981	13	13	8	7	15.4
	1982	18	18	13	10	16.2
	1983	26	26	16	14	16.9
	1984	38	37	21	20	17.7
	1985	43	42	24	23	16.5
	1986	48	48	27	27	15.4
	1987	54	54	30	30	14.3
	1988	74	71	41	40	17.3
	1989	103	96	57	54	20.7
	1990	143	131	79	73	25.0
South Korea (won)	1975	NA	NA	NA	NA	NA
	1976	20,457	65,623	81	127	33.6
	1977	25,753	70,871	94	137	23.8
	1978	35,444	79,637	115	154	23.3
	1979	47,552	89,160	138	173	27.3
	1980	47,653	71,986	114	139	22.5
	1981	42,309	54,683	93	106	14.4
	1982	55,031	66,524	120	129	12.0
	1983	50,554	58,268	106	113	8.1
	1984	49,430	54,779	100	106	5.9
	1985	48,845	52,020	96	101	4.2
	1986	59,550	61,693	116	120	3.9
	1987	68,863	68,863	133	133	3.7
	1988	90,586	85,527	175	166	3.9
	1989	104,279	94,037	NA	182	3.9
	1990	118,788	96,351	NA	187	3.7

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975–90

Page 3 of 14

Country (unit of currency)	Year	R&D in millions of currency units				Government institutes percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
Government institutes						
Taiwan (new Taiwanese dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	NA	NA	NA	NA	NA
	1979	NA	NA	NA	NA	NA
	1980	1,405	1,750	49	66	13.3
	1981	1,934	2,150	65	81	11.8
	1982	3,667	3,940	126	148	21.7
	1983	3,119	3,288	107	123	16.2
	1984	3,309	3,457	115	130	14.7
	1985	3,181	3,303	112	124	12.5
	1986	3,236	3,252	115	122	11.3
	1987	3,749	3,749	141	141	10.2
	1988	7,530	7,450	287	280	17.2
	1989	4,591	4,404	NA	165	8.4
	1990	12,163	11,209	NA	421	17.0
China (yuan)	1990	5,979	4,926	NA	10,110	47.1

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975–90

Page 4 of 14

Year	United States		Total Asian countries	
	Constant 1987 dollars	Government institutes percentage of total R&D	Constant 1987 $PPPs (1)	Government institutes percentage of total R&D
1975	11,253	15.2	3,808	19.0
1976	11,263	14.8	3,976	18.8
1977	10,856	14.1	4,163	18.8
1978	11,432	14.1	4,656	19.2
1979	11,458	13.5	4,972	18.8
1980	10,813	12.2	2,252	18.1
1981	10,836	11.7	5,578	17.3
1982	10,941	11.4	6,075	17.2
1983	12,160	11.9	6,231	16.1
1984	12,737	11.4	7,042	16.4
1985	13,725	11.4	7,697	16.0
1986	13,936	11.3	8,164	16.3
1987	13,413	10.7	9,052	16.6
1988	13,781	10.7	9,426	15.9
1989	13,971	10.7	9,428	14.6
1990	14,203	10.9	19,919	21.8

See explanatory information and SOURCES at the end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

Page 5 of 14

Country (unit of currency)	Year	R&D in millions of currency units				Industrial research percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
Industrial research						
India (rupee)	1975	686	1,737	188	327	19.2
	1976	802	1,939	217	365	21.4
	1977	957	2,190	259	413	22.2
	1978	1,311	2,922	371	551	24.8
	1979	1,655	3,167	439	597	25.9
	1980	2,071	3,554	524	670	27.2
	1981	2,546	3,963	625	747	27.1
	1982	3,195	4,629	770	872	26.5
	1983	3,695	4,935	842	930	26.8
	1984	4,044	5,025	863	947	22.7
	1985	4,505	5,216	914	983	21.8
	1986	5,273	5,724	1,029	1,079	21.7
	1987	5,988	5,988	1,128	1,128	21.0
	1988	7,490	6,920	1,364	1,304	22.4
	1989	8,909	7,660	NA	1,444	23.9
	1990	9,568	7,386	NA	1,392	22.9
Japan (yen)	1975	1,684,847	2,360,650	6,026	11,263	61.6
	1976	1,882,231	2,460,258	6,637	11,738	61.6
	1977	2,109,500	2,590,210	7,462	12,358	62.8
	1978	2,291,002	2,701,729	8,280	12,890	61.5
	1979	2,664,913	3,050,347	10,214	14,553	63.2
	1980	3,142,256	3,463,662	12,569	16,525	65.1
	1981	3,629,793	3,878,671	15,329	18,505	66.0
	1982	4,039,018	4,235,533	17,856	20,208	67.2
	1983	4,560,127	4,747,594	20,550	22,651	68.9
	1984	5,136,634	5,282,650	23,444	25,203	70.3
	1985	5,939,947	6,017,166	27,411	28,708	71.8
	1986	6,120,163	6,096,092	28,347	29,084	71.5
	1987	6,494,268	6,494,268	30,984	30,984	70.9
	1988	7,219,318	7,176,810	35,458	34,241	72.7
	1989	8,233,820	8,058,802	41,210	38,448	74.3
	1990	9,267,166	8,847,916	47,378	42,213	75.5

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

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Country (unit of currency)	Year	R&D in millions of currency units				Industrial research percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Industrial research				
Singapore (dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	26	34	17	19	56.9
	1979	31	39	20	21	55.5
	1980	36	41	23	23	54.2
	1981	43	45	28	25	53.0
	1982	58	59	41	33	51.9
	1983	79	77	49	43	50.8
	1984	107	104	59	58	49.8
	1985	137	135	79	75	53.1
	1986	176	177	98	98	56.6
	1987	226	226	126	126	60.3
	1988	251	241	140	134	58.2
	1989	279	261	155	145	56.2
	1990	310	285	172	158	54.2
South Korea (won)	1975	NA	NA	NA	NA	NA
	1976	15,141	48,570	60	94	24.9
	1977	41,714	114,794	151	222	38.5
	1978	53,802	120,884	174	234	35.3
	1979	59,294	111,176	172	215	34.1
	1980	81,351	122,892	195	238	38.4
	1981	120,654	155,942	265	302	41.2
	1982	205,654	248,606	447	482	44.9
	1983	375,810	433,158	784	839	60.4
	1984	538,295	596,550	1,094	1,156	64.6
	1985	751,025	799,842	1,471	1,550	65.0
	1986	1,021,653	1,058,425	1,982	2,051	67.1
	1987	1,224,377	1,224,377	2,372	2,372	65.2
	1988	1,633,264	1,542,044	3,154	2,988	69.6
	1989	1,998,225	1,801,956	NA	3,491	73.9
	1990	2,375,760	1,927,025	NA	3,733	74.0

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

Page 7 of 14

Country (unit of currency)	Year	R&D in millions of currency units				Industrial research percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		Industrial research				
Taiwan (new Taiwanese dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	NA	NA	NA	NA	NA
	1979	NA	NA	NA	NA	NA
	1980	5,771	7,188	201	270	54.6
	1981	9,209	10,238	309	384	56.1
	1982	8,057	8,657	277	325	47.8
	1983	9,553	10,071	328	378	49.8
	1984	10,970	11,460	382	430	48.9
	1985	12,715	13,204	449	496	50.1
	1986	15,921	15,999	565	601	55.5
	1987	21,763	21,763	817	817	59.2
	1988	20,948	20,725	799	778	47.8
	1989	30,695	29,444	NA	1,106	56.0
	1990	37,491	34,551	NA	1,298	52.4
China (yuan)	1990	3,440	2,834	NA	5,817	27.1

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

Page 8 of 14

Year	United States: Constant 1987 dollars	United States: Industrial research percentage of total R&D	Total Asian countries: Constant 1987 $PPPs (1)	Total Asian countries: Industrial research percentage of total R&D
1975	49,171	68.7	11,590	58.0
1976	51,649	69.2	12,197	57.7
1977	53,383	69.7	12,993	58.7
1978	55,240	69.2	13,694	56.6
1979	58,316	69.6	15,387	58.2
1980	62,062	71.1	17,726	61.2
1981	65,699	72.1	19,964	61.9
1982	70,021	73.3	21,920	62.3
1983	74,883	73.2	24,841	64.4
1984	82,153	74.0	27,794	65.0
1985	89,265	74.0	31,811	66.3
1986	90,614	73.5	32,913	65.8
1987	92,155	73.5	35,427	65.2
1988	94,260	73.2	39,444	66.8
1989	93,944	72.4	44,634	69.0
1990	92,446	71.4	54,611	59.8

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

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Country (unit of currency)	Year	R&D in millions of currency units				University research percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
University research						
Japan (yen)	1975	545,869	764,820	1,952	3,649	19.9
	1976	606,851	793,213	2,140	3,784	19.9
	1977	657,993	807,936	2,328	3,854	19.6
	1978	748,198	882,334	2,704	4,209	20.1
	1979	817,913	936,210	3,135	4,466	19.4
	1980	871,048	960,143	3,484	4,580	18.0
	1981	966,083	1,032,323	4,079	4,925	17.5
	1982	1,026,596	1,076,544	4,538	5,136	17.1
	1983	1,090,050	1,134,862	4,913	5,414	16.5
	1984	1,132,677	1,164,875	5,169	5,557	15.5
	1985	1,174,198	1,189,463	5,419	5,674	14.2
	1986	1,202,395	1,197,666	5,570	5,714	14.0
	1987	1,283,375	1,283,375	6,122	6,122	14.0
	1988	1,318,360	1,310,597	6,474	6,252	13.3
	1989	1,389,312	1,359,781	6,953	6,487	12.5
	1990	1,499,906	1,432,050	7,668	6,832	12.2
Singapore (dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	8	11	5	6	17.9
	1979	12	15	8	8	21.3
	1980	17	19	11	11	25.3
	1981	24	26	16	14	30.0
	1982	35	35	25	19	30.8
	1983	49	48	31	27	31.6
	1984	70	68	38	38	32.5
	1985	77	76	44	42	29.9
	1986	86	86	48	48	27.6
	1987	95	95	53	53	25.5
	1988	103	99	57	55	23.9
	1989	111	104	NA	58	22.4
	1990	120	110	NA	61	21.0

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

Page 10 of 14

Country (unit of currency)	Year	R&D in millions of currency units				University research percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
		University research				
South Korea (won)	1975	NA	NA	NA	NA	NA
	1976	1,978	6,345	8	12	3.2
	1977	5,482	15,086	20	29	5.1
	1978	20,543	46,157	66	89	13.5
	1979	16,536	31,005	48	60	9.5
	1980	25,902	39,129	62	76	12.2
	1981	27,168	35,114	60	68	9.3
	1982	66,610	80,522	145	156	14.6
	1983	64,251	74,056	134	143	10.3
	1984	87,052	96,473	177	187	10.4
	1985	118,802	126,524	233	245	10.3
	1986	164,286	170,199	319	330	10.8
	1987	198,067	198,067	384	384	10.5
	1988	232,827	219,823	450	426	9.9
	1989	229,212	206,698	NA	400	8.5
	1990	243,994	197,911	NA	383	7.6
Taiwan (new Taiwanese dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	NA	NA	NA	NA	NA
	1979	NA	NA	NA	NA	NA
	1980	2,280	2,840	79	107	21.6
	1981	2,676	2,975	90	112	16.3
	1982	3,147	3,382	108	127	18.7
	1983	3,842	4,050	132	152	20.0
	1984	4,149	4,334	144	163	18.5
	1985	4,282	4,447	151	167	16.9
	1986	4,424	4,446	157	167	15.4
	1987	5,173	5,173	194	194	14.1
	1988	7,265	7,188	277	270	16.6
	1989	8,267	7,930	NA	298	15.1
	1990	9,444	8,704	NA	327	13.2
China (yuan)	1990	1,193	983	NA	2,018	9.4

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

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Year	United States		Total Asian countries	
	Constant 1987 dollars	University research percentage of total R&D	Constant 1987 $PPPs [1]	University research percentage of total R&D
1975	10,392	12.5	3,649	18.2
1976	10,683	12.5	3,796	18.0
1977	10,889	12.7	3,884	17.5
1978	11,453	13.2	4,305	17.8
1979	11,743	13.3	4,535	17.1
1980	12,173	13.3	4,733	16.4
1981	12,595	13.0	5,119	15.9
1982	12,240	12.2	5,438	15.4
1983	12,822	11.9	5,736	14.8
1984	13,581	11.6	5,944	13.9
1985	14,729	11.6	6,129	12.8
1986	16,151	12.4	6,258	12.5
1987	17,321	13.1	6,753	12.4
1988	18,603	13.5	7,003	11.9
1989	19,129	14.0	7,243	11.8
1990	20,003	14.5	9,621	10.5

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

Country (unit of currency)	Year	R&D in millions of currency units				Nonprofit research institutes percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs (1)	Constant 1987 $PPPs (1)	
Nonprofit research institutes						
Japan (yen)	1975	142,279	199,348	509	951	5.2
	1976	126,850	165,805	447	791	5.3
	1977	113,094	138,866	400	662	4.5
	1978	100,830	118,907	364	567	4.9
	1979	94,601	108,283	363	517	4.0
	1980	145,541	160,428	582	765	4.0
	1981	245,520	262,354	1,037	1,252	4.5
	1982	276,178	289,615	1,221	1,382	4.6
	1983	279,649	291,145	1,260	1,389	4.2
	1984	307,422	316,161	1,403	1,508	4.2
	1985	349,812	354,360	1,614	1,690	4.2
	1986	400,006	398,433	1,853	1,901	4.7
	1987	441,269	441,269	2,105	2,105	4.8
	1988	458,925	456,223	2,253	2,176	4.6
	1989	498,394	487,800	2,494	2,327	4.5
	1990	540,374	515,927	2,763	2,461	4.4
South Korea (won)	1975	NA	NA	NA	NA	NA
	1976	23,322	74,813	93	145	38.3
	1977	35,334	97,237	128	188	32.6
	1978	42,626	95,774	138	186	28.0
	1979	50,655	94,978	147	184	29.1
	1980	56,818	85,831	136	166	26.8
	1981	103,000	133,125	226	258	35.1
	1982	131,045	158,414	285	307	28.6
	1983	130,002	149,840	271	290	20.9
	1984	154,620	171,353	314	332	18.5
	1985	231,401	246,442	453	477	20.0
	1986	273,689	283,540	531	549	18.0
	1987	386,658	386,658	749	749	20.6
	1988	390,738	368,915	755	715	16.6
	1989	373,360	336,688	NA	652	13.8
	1990	475,152	385,405	NA	747	14.8

See explanatory information and SOURCES at end of table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

Page 13 of 14

Country (unit of currency)	Year	R&D in millions of currency units				Nonprofit research institutes percentage of total R&D
		Current year units	Constant 1987 units	Current $PPPs [1]	Constant 1987 $PPPs [1]	
		Nonprofit research institutes				
Taiwan (new Taiwanese dollar)	1975	NA	NA	NA	NA	NA
	1976	NA	NA	NA	NA	NA
	1977	NA	NA	NA	NA	NA
	1978	NA	NA	NA	NA	NA
	1979	NA	NA	NA	NA	NA
	1980	1,106	1,378	38	52	10.5
	1981	2,594	2,884	87	108	15.8
	1982	1,992	2,140	68	80	11.8
	1983	2,685	2,831	92	106	14.0
	1984	4,016	4,196	140	158	17.9
	1985	5,219	5,420	184	204	20.5
	1986	5,121	5,146	182	193	17.8
	1987	6,094	6,094	229	229	16.6
	1988	8,037	7,952	307	299	18.3
	1989	11,236	10,778	NA	405	20.5
	1990	12,449	11,473	NA	431	17.4
China (yuan)	1990	2,082	1,745	NA	3,520	16.4

See explanatory information and SOURCES at end of the table.

Table A-18. R&D in selected Asian countries and the United States, by performer: 1975-90

Year	United States		Total Asian countries	
	Constant 1987 dollars	Nonprofit research institutes percentage of total R&D	Constant 1987 dollars	Nonprofit research institutes percentage of total R&D
1975	2,074	3.6	951	4.8
1976	2,239	3.5	936	4.4
1977	2,499	3.5	851	3.8
1978	2,882	3.5	753	3.1
1979	2,989	3.6	701	2.6
1980	3,182	3.4	983	3.4
1981	3,197	3.2	1,618	5.0
1982	2,967	3.0	1,769	5.0
1983	3,145	3.0	1,786	4.6
1984	3,467	3.0	1,998	4.7
1985	3,735	3.0	2,371	4.9
1986	4,011	2.8	2,643	5.3
1987	4,206	2.7	3,083	5.7
1988	4,372	2.7	3,190	5.4
1989	4,369	2.9	3,384	5.2
1990	4,288	3.2	7,159	7.8

(1) $PPP = Purchasing power parity dollars

NOTES: India does not report university research or nonprofit research institutes. Singapore does not report nonprofit research institutes. Japanese data are adjusted for full-time equivalents.

KEY: NA = Not available

SOURCES: China: Government of the People's Republic of China, State Science and Technology Commission, Division of Statistics, Department of Planning; India: Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Organization for Economic Cooperation and Development, 1992, *Main Science and Technology Indicators* (Paris); Singapore: Government of Singapore, National Science and Technology Board, 1990, *National Survey of R&D Expenditures and Manpower*, and Government of Singapore, Science Council of Singapore, 1982–88, *National Survey of R&D Expenditures and Manpower*; South Korea: Government of the Republic of Korea, Ministry of Science and Technology, 1990, *1989 Report on the Survey of Research and Development in Science and Technology* (Seoul); Taiwan: Government of the Republic of China, National Science Council, 1987, *Science and Technology Databook*, (Taipei); United States: National Science Foundation, 1992, *National Patterns of R&D Resources: 1992*, NSF 92-330 (Washington, DC)

Table A-[illegible] Scientists and engineers in R&D in selected Asian countries and the United States and as a percentage of the labor force: 1975–90

[In thousands]

Page 1 of 2

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total	United States
1975 . .	NA	NA	253.6	NA	10.3	NA	263.9	527.4
1976 . .	NA	54.1	263.2	NA	11.7	NA	329.0	535.2
1977 . .	NA	55.3	264.8	NA	12.8	NA	332.9	560.6
1978 . .	NA	56.5	272.8	0.8	14.7	NA	344.8	587.6
1979 . .	NA	60.6	291.2	.9	15.7	NA	368.4	614.5
1980 . .	NA	64.9	303.2	1.0	18.4	6.2	393.7	651.1
1981 . .	NA	68.2	310.9	1.2	20.7	9.4	410.4	683.2
1982 . .	NA	71.6	321.0	1.4	28.4	10.4	432.8	711.8
1983 . .	NA	74.7	347.4	1.7	32.1	12.1	468.0	751.6
1984 . .	NA	78.0	357.4	2.4	37.1	17.6	492.5	797.6
1985 . .	NA	81.6	380.8	2.7	41.4	20.1	526.5	841.6
1986 . .	NA	85.3	393.0	3.0	47.0	21.5	549.8	882.3
1987 . .	NA	90.9	415.6	3.4	52.8	23.5	586.2	910.2
1988 . .	NA	96.9	434.6	3.3	56.5	25.6	617.0	927.3
1989 . .	NA	96.9	457.5	3.3	60.0	28.3	646.0	949.3
1990 . .	391.1	106.0	477.9	4.3	68.8	32.1	1,080.2	NA
				Total labor force				
1975 . .	481,759	243,480	55,678	909	13,054	5,656	800,536	95,453
1976 . .	494,819	247,848	55,962	951	13,389	5,772	818,741	97,826
1977 . .	507,879	252,217	56,246	992	13,724	6,087	837,145	100,665
1978 . .	520,939	256,584	56,529	1,034	14,059	6,333	855,478	103,882
1979 . .	533,999	260,952	56,813	1,075	14,394	6,507	873,740	106,559
1980 . .	547,059	265,320	57,097	1,116	14,729	6,629	891,950	108,544
1981 . .	561,229	270,895	57,632	1,138	15,141	6,764	912,799	110,315
1982 . .	575,398	276,469	58,167	1,160	15,553	6,960	933,707	111,872
1983 . .	589,567	282,044	58,702	1,182	15,965	7,266	954,726	113,226
1984 . .	603,736	287,618	59,237	1,204	16,377	7,491	975,663	115,241
1985 . .	617,905	293,193	59,772	1,226	16,789	7,651	996,536	117,167
1986 . .	630,304	299,143	60,258	1,240	17,164	7,945	1,016,054	119,540
1987 . .	642,703	305,093	60,744	1,255	17,539	8,183	1,035,517	121,602
1988 . .	655,102	311,044	61,230	1,269	17,914	8,250	1,054,809	123,378
1989 . .	667,501	316,994	61,716	1,283	18,289	8,400	1,074,183	125,557
1990 . .	697,300	316,994	63,840	1,412	18,487	8,420	1,106,453	NA

See explanatory information and SOURCES at end of table.

Table A-19. Scientists and engineers in R&D in selected Asian countries and the United States and as a percentage of the labor force: 1975–90

[In thousands]

Page 2 of 2

Year	China	India	Japan	Singapore	South Korea	Taiwan	Total	United States
	Scientists and engineers in research and development per 10,000 of the labor force							
1975 . .	NA	NA	45.55	NA	7.89	NA	3.30	55.25
1976 . .	NA	2.18	47.03	NA	8.74	NA	4.02	54.71
1977 . .	NA	2.19	47.08	NA	9.33	NA	3.98	55.69
1978 . .	NA	2.20	48.26	7.74	10.46	NA	4.03	56.56
1979 . .	NA	2.32	51.26	8.52	10.91	NA	4.22	57.67
1980 . .	NA	2.45	53.10	9.39	12.49	9.36	4.41	59.98
1981 . .	NA	2.52	53.96	10.54	13.67	13.96	4.50	61.93
1982 . .	NA	2.59	55.19	12.30	18.26	14.97	4.64	63.63
1983 . .	NA	2.65	59.11	14.36	20.11	16.59	4.90	66.38
1984 . .	NA	2.71	60.27	19.93	22.65	23.47	5.05	69.21
1985 . .	NA	2.78	63.74	21.99	24.66	26.24	5.28	71.83
1986 . .	NA	2.85	65.22	24.41	27.38	27.01	5.41	73.81
1987 . .	NA	2.98	68.48	27.09	30.10	28.77	5.66	74.85
1988 . .	NA	3.12	71.04	26.40	31.54	31.04	5.85	75.16
1989 . .	NA	3.06	74.21	25.72	32.81	33.63	6.01	75.61
1990 . .	5.61	3.34	74.21	30.45	37.22	38.12	9.76	NA

KEY: NA = Not available

SOURCE: Labor Force: Japan: Organisation for Economic Co-operation and Development, 1992, *Main Science and Technology Indicators* (Paris) uses adjusted data for Japan; other Asian countries: World Bank, 1991, *Indicators of Social Development*, (Washington, DC); United States: U.S. Department of Labor, Bureau of Labor Statistics, 1990, *Employment & Earnings* (Washington, DC)

Scientists and Engineers in R&D: China: Government of the People's Republic of China, State Science and Technology Commission, Division of Statistics, Department of Planning; India: Government of India, Department of Science and Technology, n.d., *Research and Development Statistics, 1990–91* (New Delhi); Japan: Organization for Economic Cooperation and Development, 1992, *Main Science and Technology Indicators* (Paris); Singapore: Government of Singapore, National Science and Technology Board, 1990, *National Survey of R&D Expenditures and Manpower*, and Government of Singapore, Science Council of Singapore, 1982–88, *National Survey of R&D Expenditures and Manpower*; South Korea: Government of the Republic of Korea, Ministry of Science and Technology, 1990, *1989 Report on the Survey of Research and Development in Science and Technology* (Seoul); Taiwan: Government of the Republic of China, National Science Council, 1987, *Science and Technology Databook*, (Taipei); United States: National Science Foundation, 1992, *National Patterns of R&D Resources: 1992*, NSF 92-330 (Washington, DC)

Table A-20. R&D expenditures per research scientist and engineer in selected Asian countries and the United States: 1975–90

Page 1 of 1

Year	China	India	Japan	Singapore	South Korea	Taiwan	United States
1975	NA	NA	72,177	NA	NA	NA	137,004
1976	NA	31,496	72,291	NA	32,349	NA	140,256
1977	NA	33,576	74,205	NA	45,104	NA	136,921
1978	NA	39,278	76,718	42,089	45,134	NA	136,534
1979	NA	38,019	79,190	42,207	40,268	NA	136,884
1980	NA	37,914	83,623	40,047	33,677	79,631	134,643
1981	NA	40,489	90,207	39,682	35,459	72,558	133,858
1982	NA	45,993	93,751	44,290	37,743	65,314	134,292
1983	NA	46,504	94,665	49,562	43,251	63,066	136,123
1984	NA	53,457	100,248	48,136	48,259	50,071	139,339
1985	NA	55,315	105,031	52,253	57,571	49,338	143,327
1986	NA	58,403	103,548	57,488	65,051	50,480	139,711
1987	NA	59,126	105,191	61,225	68,908	58,671	137,720
1988	NA	60,127	108,378	68,622	75,997	63,596	138,950
1989	NA	62,280	113,039	78,216	78,767	69,864	136,825
1990	54,884	57,456	117,068	67,855	73,297	77,032	NA

SOURCE: Computed, tables A-16 and A-19

Table A-21. U.S. patents granted to inventors from selected Asian countries: 1975–90

Page 1 of 1

Year	China	India	Japan	Singapore	South Korea	Taiwan
1975	1	13	6,350	1	11	23
1976	6	17	6,539	3	7	28
1977	1	13	6,217	3	5	52
1978	0	14	6,910	2	12	29
1979	2	14	5,250	0	4	38
1980	1	4	7,124	3	8	65
1981	3	6	8,387	4	15	80
1982	0	4	8,149	3	14	88
1983	1	14	8,792	5	26	65
1984	2	12	11,109	4	29	98
1985	1	10	12,743	9	38	174
1986	9	18	13,198	3	45	208
1987	23	12	16,539	11	84	343
1988	47	14	16,137	6	95	457
1989	52	14	20,100	18	157	592
1990	46	24	19,444	12	224	731

SOURCE: U.S. Department of Commerce, Patent and Trademark Office, 1991, *Patenting Trends in the United States: United States Country Report 1963–90* (Washington, DC)

Table A-22. Gross domestic product in selected Asian countries and the United States: 1975–90

Page 1 of 4

Country (number of currency units)	Year	Current year units	Deflator 1987 = 100	PPP (1)	Constant 1987 units	Current $PPPs (2) (millions)	Constant 1987 $PPPs (2) (millions)
China (millions of yuan)	1975 . . .	NA	NA	NA	NA	NA	NA
	1976 . . .	NA	NA	NA	NA	NA	NA
	1977 . . .	NA	NA	NA	NA	NA	NA
	1978 . . .	358,810	0.4429	0.4991	810,193	718,860	1,662,924
	1979 . . .	399,810	.4765	.4768	839,006	838,593	1,722,064
	1980 . . .	446,900	.5137	.4513	869,914	990,146	1,785,502
	1981 . . .	477,510	.5368	.4206	889,618	1,135,243	1,825,945
	1982 . . .	518,230	.5837	.4041	887,833	1,282,331	1,822,280
	1983 . . .	578,700	.6439	.4003	898,696	1,445,530	1,844,578
	1984 . . .	692,820	.7378	.4153	939,008	1,668,320	1,927,318
	1985 . . .	852,740	.8317	.4361	1,025,286	1,955,178	2,104,403
	1986 . . .	968,760	.9008	.4665	1,075,447	2,076,655	2,207,360
	1987 . . .	1,130,710	1.0000	.4872	1,130,710	2,320,787	2,320,787
	1988 . . .	1,402,420	1.1098	.5174	1,263,633	2,710,734	2,593,612
	1989 . . .	1,592,060	1.1537	NA	1,379,989	NA	2,832,433
	1990 . . .	1,767,110	1.2139	NA	1,455,722	NA	2,987,875
India (millions of rupees)	1975 . . .	787,610	0.3950	3.6559	1,994,089	215,436	375,775
	1976 . . .	848,910	.4137	3.6936	2,052,030	229,833	386,694
	1977 . . .	950,670	.4370	3.6889	2,175,449	257,708	409,952
	1978 . . .	1,041,900	.4487	3.5360	2,322,286	294,658	437,622
	1979 . . .	1,143,560	.5226	3.7715	2,188,061	303,212	412,328
	1980 . . .	1,360,130	.5827	3.9560	2,334,322	343,817	439,890
	1981 . . .	1,597,600	.6424	4.0761	2,486,845	391,944	468,633
	1982 . . .	1,781,320	.6902	4.1516	2,580,862	429,069	486,349
	1983 . . .	2,075,890	.7487	4.3867	2,772,549	473,221	522,472
	1984 . . .	2,313,870	.8048	4.6847	2,875,147	493,924	541,806
	1985 . . .	2,619,200	.8638	4.9266	3,032,304	531,643	571,421
	1986 . . .	2,919,740	.9211	5.1250	3,169,741	569,702	597,321
	1987 . . .	3,326,160	1.0000	5.3066	3,326,160	626,797	626,797
	1988 . . .	3,949,920	1.0823	5.4911	3,649,433	719,328	687,716
	1989 . . .	4,506,010	1.1630	NA	3,874,330	NA	730,096
	1990 . . .	5,295,370	1.2953	NA	4,088,003	NA	770,362

See explanatory information and SOURCES at end of table.

Table A-22. Gross domestic product in selected Asian countries and the United States: 1975–90

Page 2 of 4

Country (number of currency units)	Year	Current year units	Deflator 1987 = 100	PPP (1)	Constant 1987 units	Current $PPPs (2) (millions)	Constant 1987 $PPPs (2) (millions)
Japan (billions of yen)	1975 . . .	148,328	0.7137	279.6000	207,823	530,501	991,523
	1976 . . .	166,573	.7651	283.6000	217,727	587,352	1,038,774
	1977 . . .	185,622	.8144	282.7000	227,921	656,604	1,087,411
	1978 . . .	204,405	.8480	276.7000	241,050	738,724	1,150,049
	1979 . . .	221,546	.8736	260.9000	253,589	849,161	1,209,870
	1980 . . .	240,177	.9072	250.0000	264,744	960,708	1,263,089
	1981 . . .	257,364	.9358	236.8000	275,010	1,086,841	1,312,072
	1982 . . .	269,628	.9536	226.2000	282,747	1,191,989	1,348,982
	1983 . . .	280,256	.9605	221.9000	291,777	1,262,983	1,392,067
	1984 . . .	297,948	.9724	219.1000	306,418	1,359,872	1,461,916
	1985 . . .	316,303	.9872	216.7000	320,415	1,459,635	1,528,697
	1986 . . .	330,025	1.0039	215.9000	328,727	1,528,601	1,568,354
	1987 . . .	343,238	1.0000	209.6000	343,238	1,637,586	1,637,586
	1988 . . .	364,385	1.0059	203.6000	362,239	1,789,710	1,728,242
	1989 . . .	386,840	1.0217	199.8000	378,617	1,936,136	1,806,380
	1990 . . .	414,758	1.0474	195.6000	395,994	2,120,440	1,889,285
Singapore (millions of Singapore dollars)	1975 . . .	13,373	0.7118	1.7925	18,787	7,461	10,437
	1976 . . .	14,651	.7261	1.7067	20,179	8,584	11,210
	1977 . . .	16,039	.7373	1.6636	21,755	9,641	12,086
	1978 . . .	17,830	.7546	1.5670	23,629	11,378	13,127
	1979 . . .	20,523	.7953	1.5366	25,805	13,356	14,336
	1980 . . .	25,091	.8859	1.5676	28,321	16,006	15,734
	1981 . . .	29,339	.9450	1.5247	31,046	19,242	17,248
	1982 . . .	32,670	.9847	1.4008	33,177	23,322	18,432
	1983 . . .	36,733	1.0234	1.5926	35,892	23,065	19,940
	1984 . . .	40,048	1.0305	1.8133	38,861	22,086	21,589
	1985 . . .	38,924	1.0183	1.7422	38,223	22,342	21,235
	1986 . . .	38,654	.9929	1.8000	38,932	21,474	21,629
	1987 . . .	42,609	1.0000	1.8000	42,609	23,672	23,672
	1988 . . .	49,365	1.0428	1.8000	47,340	27,425	26,300
	1989 . . .	55,310	1.0692	1.8000	51,728	30,728	28,738
	1990 . . .	63,905	1.0896	1.8000	58,649	35,503	32,583

See explanatory information and SOURCES at end of table.

Table A-22. Gross domestic product in selected Asian countries and the United States: 1975–90

Country (number of currency units)	Year	Current year units	Deflator 1987 = 100	PPP [1]	Constant 1987 units	Current $PPPs [2] (millions)	Constant 1987 $PPPs [2] (millions)
South Korea (billions of won)	1975 . . .	10,224	0.2582	215.7188	39,595	47,395	76,710
	1976 . . .	13,996	.3117	251.3412	44,897	55,685	86,982
	1977 . . .	18,074	.3634	275.3960	49,739	65,629	96,362
	1978 . . .	24,237	.4451	309.0340	54,457	78,428	105,503
	1979 . . .	31,323	.5333	344.8500	58,731	90,831	113,783
	1980 . . .	38,041	.6620	416.8792	57,466	91,252	111,333
	1981 . . .	47,482	.7737	455.8815	61,369	104,154	118,895
	1982 . . .	54,443	.8272	459.6300	65,814	118,450	127,506
	1983 . . .	63,833	.8676	479.1032	73,574	133,234	142,540
	1984 . . .	72,644	.9023	492.2120	80,506	147,587	155,969
	1985 . . .	80,847	.9390	510.4407	86,102	158,387	166,812
	1986 . . .	93,426	.9653	515.5601	96,789	181,213	187,516
	1987 . . .	108,428	1.0000	516.1627	108,428	210,066	210,066
	1988 . . .	127,963	1.0592	517.8076	120,816	247,125	234,066
	1989 . . .	143,001	1.1089	NA	128,955	NA	249,834
	1990 . . .	172,724	1.2329	NA	140,100	NA	271,426
Taiwan (millions of new Taiwanese dollars)	1975 . . .	589,651	0.6331	26.62	931,374	22,148	34,976
	1976 . . .	707,710	.6507	26.41	1,087,594	26,793	40,843
	1977 . . .	828,995	.5883	26.46	1,409,095	31,335	52,917
	1978 . . .	991,602	.6197	26.48	1,600,226	37,454	60,094
	1979 . . .	1,195,838	.6909	26.76	1,730,805	44,684	64,998
	1980 . . .	1,491,069	.8029	28.74	1,857,183	54,886	69,744
	1981 . . .	1,773,931	.8995	29.83	1,972,147	59,476	74,061
	1982 . . .	1,899,971	.9306	29.12	2,041,575	65,256	76,669
	1983 . . .	2,100,005	.9486	29.11	2,213,906	72,150	83,140
	1984 . . .	2,343,078	.9572	28.73	2,447,821	81,541	91,925
	1985 . . .	2,473,786	.9630	28.34	2,568,882	87,298	96,471
	1986 . . .	2,855,180	.9951	28.19	2,869,170	101,294	107,748
	1987 . . .	3,222,993	1.000	26.63	3,222,993	121,035	121,035
	1988 . . .	3,496,951	1.0107	26.22	3,459,768	133,395	129,927
	1989 . . .	3,878,547	1.0425	NA	3,720,458	NA	139,717
	1990 . . .	4,222,004	1.0851	NA	3,890,950	NA	146,119

See explanatory information and SOURCES at end of table.

Table A-22. Gross domestic product in selected Asian countries and the United States: 1975–90

Page 4 of 4

Year	United States			Asia total	
	Deflator 1.00 = 1987	Current dollars	Constant 1987 dollars	Current dollars	Constant 1987 dollars
1975 . . .	0.4919	1,584,820	3,221,834	822,940	1,489,422
1976 . . .	.5227	1,767,060	3,380,639	908,248	1,564,503
1977 . . .	.5587	1,974,120	3,533,417	1,020,918	1,658,727
1978 . . .	.6029	2,232,690	3,703,251	1,879,503	3,429,320
1979 . . .	.6555	2,488,630	3,796,537	2,139,836	3,537,380
1980 . . .	.7171	2,708,040	3,776,377	2,453,815	3,685,293
1981 . . .	.7886	3,030,600	3,843,013	2,796,901	3,816,854
1982 . . .	.8376	3,149,590	3,760,255	3,110,416	3,880,216
1983 . . .	.8716	3,405,050	3,906,666	3,410,184	4,004,737
1984 . . .	.9105	3,777,200	4,148,490	3,773,330	4,200,523
1985 . . .	.9437	4,038,730	4,279,676	4,214,482	4,489,040
1986 . . .	.9692	4,268,640	4,404,292	4,478,939	4,689,926
1987 . . .	1.0000	4,539,930	4,539,930	4,939,942	4,939,942
1988 . . .	1.0385	4,900,380	4,718,710	5,627,717	5,399,862
1989 . . .	1.0842	5,244,030	4,836,774	NA	5,787,198
1990 . . .	1.1287	5,513,740	4,885,036	NA	6,097,651

(1) PPP = Purchasing power parity exchange

(2) $PPPs = Purchasing power parity dollars

KEY: NA = Not available

SOURCES: China: Government of the People's Republic of China, 1991, *Statistical Yearbook of China* (Beijing); India: Government of India, Central Statistical Organization, 1991, *National Accounts Statistics, 1991* (New Delhi); Japan: Organization for Economic Cooperation and Development, 1992, *Main Science and Technology Indicators* (Paris); Singapore and South Korea: International Monetary Fund, 1991, *International Financial Statistics Yearbook* (Washington, DC); Taiwan: Government of the Republic of China, National Science Council, 1991, *Statistical Yearbook of the Republic of China* (Taipei); United States: National Science Foundation, 1992, *National Patterns of R&D Resources: 1992*, NSF 92-330 (Washington, DC)

Table A-23. Asian doctoral recipients from U.S. universities who plan to stay in the United States, by field: 1980, 1990, and 1991

Page 1 of 3

Country	Total (1)	Plan to stay (2)		Firm plan to stay (3)	
		Number	Percentage	Number	Percentage
			Engineering		
			1980		
China (4)	84	39	46.4	32	38.1
Taiwan	172	114	66.3	96	55.8
Japan	27	7	25.9	5	18.5
S. Korea	41	25	61.0	24	58.5
India	184	143	77.7	121	65.8
Total	508	328	64.6	278	54.7
			1990		
China	289	162	56.1	90	31.1
Taiwan	474	207	43.7	134	28.3
Japan	17	5	29.4	4	23.5
S. Korea	359	103	28.7	66	18.4
India	313	210	67.1	161	51.4
Total	1,452	687	47.3	455	31.3
			1991		
China	415	341	82.2	167	40.2
Taiwan	573	293	51.1	162	28.3
Japan	28	7	25.0	6	21.4
S. Korea	412	148	35.9	78	18.9
India	338	271	80.2	190	56.2
Total	1,766	1,060	60.0	603	34.1
			Natural science		
			1980		
China (4)	196	118	60.2	99	50.5
Taiwan	227	141	62.1	118	52.0
Japan	20	12	60.0	8	40.0
S. Korea	46	26	56.5	20	43.5
India	155	105	67.7	80	51.6
Total	644	402	62.4	325	50.5

See explanatory information and SOURCE at end of table.

Table A-23. Asian doctoral recipients from U.S. universities who plan to stay in the United States, by field: 1980, 1990, and 1991

Page 2 of 3

Country	Total (1)	Plan to stay (2)		Firm plan to stay (3)	
		Number	Percentage	Number	Percentage
Natural science					
1990					
China	675	423	62.7	323	47.9
Taiwan	457	221	48.4	153	33.5
Japan	58	31	53.4	25	43.1
S. Korea	407	168	41.3	134	32.9
India	317	220	69.4	180	56.8
Total	1,914	1,063	55.5	815	42.6
1991					
China	1,105	924	83.6	611	55.3
Taiwan	408	246	60.3	151	37.0
Japan	45	25	55.6	17	37.8
S. Korea	415	186	44.8	131	31.6
India	295	225	76.3	174	59.0
Total	2,268	1,606	70.8	1,084	47.8
Social science					
1980					
China (4)	10	5	50.0	4	40.0
Taiwan	24	11	45.8	10	41.7
Japan	22	6	27.3	6	27.3
S. Korea	44	13	29.5	10	22.7
India	30	17	56.7	11	36.7
Total	130	52	40.0	41	31.5
1990					
China	53	31	58.5	21	39.6
Taiwan	78	22	28.2	12	15.4
Japan	72	24	33.3	19	26.4
S. Korea	204	36	17.6	26	12.7
India	75	36	48.0	29	38.7
Total	482	149	30.9	107	22.2

See explanatory information and SOURCE at end of table.

Table A-23. Asian doctoral recipients from U.S. universities who plan to stay in the United States, by field: 1980, 1990, and 1991

Country	Total (1)	Plan to stay (2)		Firm plan to stay (3)	
		Number	Percentage	Number	Percentage
Social science					
1991					
China	76	58	76.3	29	38.2
Taiwan	101	38	37.6	31	30.7
Japan	47	18	38.3	12	25.5
S. Korea	240	55	22.9	33	13.8
India	86	56	65.1	42	48.8
Total	550	225	40.9	147	26.7

(1) Total doctoral recipients by field

(2) Plan to stay = think that they will locate in the United States

(3) Firm plan to stay = have postdoctoral research appointment or academic, industrial, or other firm employment in the United States

(4) 1987 was the earliest year for which data for China were available.

SOURCE: National Research Council, 1992, *Survey of Earned Doctorates* (Washington, DC)

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